Appendix A. Noise Analysis for Montana Army National Guard Limited Army Aviation Support Facility Environmental Assessment

Blue Ridge Research and Consulting, LLC

Technical Report [BRRC21-11] (Final)

Noise Analysis for Montana Army National Guard Limited Army Aviation Support Facility Environmental Assessment

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TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Overview of the Noise Study 1
1.2 Team Members 1
1.3 Purpose and Document Structure 1
2 METHODOLOGY 3
2.1 Points of Interest 3
2.2 Noise Modeling and Installation/Airport Primary Noise Metrics 7
2.2.1 Day/Night Average Sound Level, DNL or Ldn 7
2.2.2 Maximum Sound Level (L_{Amax}) 8
2.2.3 Sound Exposure Level (SEL) 8
2.2.4 Residential Nighttime Sleep Disturbance 8
2.3 Computerized Noise Exposure Models 9
3 FLIGHT TRACK AND FLIGHT PROFILE MODELING DATA DEVELOPMENT 10
3.1 Summary Flight Tracks 10
3.1.1 Proposed Action MTARNG Helicopter Flight Tracks 12
3.1.2 Billings Flying Service Helicopter Flight Tracks 12
3.1.3 KBIL Civil Air Carrier and Transient Military Flight Tracks 22
3.1.4 KBIL GA Aircraft Flight Tracks 29
3.2 Flight Profiles 44
3.3 Ground Run Ups 44
4 DEVELOPMENT OF FLIGHT OPERATION DISTRIBUTIONS 45
4.1 Annual Operations 45
4.2 Runway Utilization 48
4.3 Percentages of Operations During Acoustic Day and Acoustic Night 48
4.4 Modeled KBIL Weather Data, Runway Coordinates, and Annual Tower Counts 50
5 DNL NOISE RESULTS 52
6 SUMMARY OF THE NOISE ANALYSIS 57
7 REFERENCES 58
APPENDIX A MODELED AIRCRAFT FLIGHT TRACKS 60
APPENDIX B REPRESENTATIVE FLIGHT PROFILES 139

LIST OF FIGURES

Figure 2-1. Map of the POI Locations 5
Figure 2-2. Zoomed-in Map of the East POI Locations 6
Figure 3-1. Proposed Action MTARNG Flight Corridors 10
Figure 5-1. MTARNG Noise Analysis Proposed Action 55-80 dBA DNL Contours in Red and No Action DNL Contours in Blue 53
Figure 5-2. Zoomed-in Image of the MTARNG Noise Analysis Proposed Action 55-80 dBA DNL Contours in Red and No Action DNL Contours in Blue 54

LIST OF TABLES

Table 2-1. Points of Interest for the Noise Analysis 4
Table 4-1. Billings International Airport No Action (Baseline) Annual Operations 46
Table 4-2. Billings International Airport Proposed Action Annual Operations 47
Table 4-3. Modeled Civil and Transient Aircraft Runway Utilization at KBIL 48
Table 4-4. Modeled Percentages of Operations during Acoustic Day and Acoustic Night at KBIL 49
Table 4-5. KBIL 5-year Monthly Average Weather Data (2016-2020) 50
Table 4-6. KBIL Runway and Billings Flying Service Helipad Modeling Information 51
Table 4-7. KBIL Annual Tower Operations from the Air Traffic Activity Reports 51
Table 5-1. DNL Results for the Proposed Action and No Action at the Points of Interest 55
Table 5-2. Probability of Awakening for the Proposed Action and No Action at the Points of Interest 56

1 INTRODUCTION

1.1 Overview of the Noise Study

The objective of this effort is to generate Day-Night Average Sound Level (DNL) contours for the Environmental Assessment (EA) study for the development and operation of a Limited Army Aviation Support Facility (LAASF) in Billings, Montana. The Montana Army National Guard (MTARNG) will be utilizing a leased private hangar for the proposed aircraft operations. The hangar will be used to support up to six (6) aviation assets, including a mixture of UH-60, HH-60, CH-47, and LUH-72 aircraft that is assigned to the 1-189th General Support Aviation Battalion (GSAB).

Under the Proposed Action, MTARNG will operate a LAASF out of a proposed hangar owned by Billings Flying Service (BFS) and is located west of the Billings International Airport (KBIL) in Billings, Montana. The MTARNG helicopters would utilize the same helipad that is located behind the existing BFS hangar. The noise analysis for the Proposed Action includes the proposed MTARNG helicopter operations in addition to the baseline BFS and KBIL operations. Under the No Action, the LAASF not operate out of Billings, Montana, and the noise analysis reflects just the baseline KBIL and BFS operations.

Datasets for this analysis were collected via a site visit in Billings, MT from June 30th through July 1st, 2021, as well as from follow-up communications with KBIL and MTARNG personnel. These comprehensive datasets include the operational figures (e.g., annual operations and the types of operations flown), flight tracks, flight profiles, runway and flight track utilization, and static operation locations and activities for the proposed LAASF helicopters, BFS operations, and civil and transient military aircraft at KBIL. This noise study presents the datasets used in the noise analysis, the DNL noise contours, and DNL noise results at the Billing, MT points of interest.

1.2 Team Members

Noise Modeling:	Blue Ridge Research and Consulting, LLC - Ben Manning and Dr. Micah Downing
EA Team:	Jacobs – Nancy Shelton, Sabra Bushey, and Michelle York
Department of Military Affairs:	Rebekah Myers
MTARNG:	COL Robert Oleson, COL Beverly Schneider,
	COL Todd Verrill, LTC John Gehring, LTC Noah Genger, LTC Adel Johnson, MAJ Robert Allinson, LT Kevin Stein
Billings International Airport:	Shane Ketterling
Federal Aviation Administration:	Scott Miller, Casey Allen, and Robert Forney

1.3 Purpose and Document Structure

This document provides the results of the DNL noise analysis in support of the MTARNG LAASF EA and a summary of the operational data utilized for the noise analysis. These operational data include flight tracks, flight operational distributions, helicopter flight profiles and run-ups, and weather data. Additionally, detailed inputs to the modeling are provided in the attached appendices. Section 1 presents the introduction to the noise study and analysis; Section 2 discusses the methodology of the noise analysis, the noise metrics that will be presented, and the noise modeling software that is used for the analysis; Section 3 presents the flight track and profile data development; Section 4 presents the flight operational data development and distributions; Section 5 presents the DNL noise results for the Proposed Action and the No Action as well as the DNL at the points of interest; and Section 6 concludes the report.

2 METHODOLOGY

Noise represents one of the most contentious environmental issues associated with aircraft operations. Although many other sources of noise are present in today's communities, aircraft noise is readily identifiable based on its uniqueness. An assessment of aircraft noise requires a general understanding of how sound affects people and the natural environment, as well as how it is measured.

Around a military or civilian airfield, the noise environment is normally described in terms of the time-averaged sound level generated by aircraft operating at that facility. In this study, operations consist of the fixed-wing and helicopter flight activities conducted during an average annual day, including arrivals and departures at the airfield, flight patterns in the general vicinity of the airfield, helicopter operations at Billings Flying Service, and static maintenance operations.

2.1 Points of Interest

Thirty-five Points of Interest (POI) including hospitals, parks, residential areas, schools, and places of worship are included in the analysis. Several of these points were provided by the MTARNG, and others were found by searching Google Maps for locations near the airport. The POI are listed in Table 2-1 and are shown in Figure 2-1. Figure 2-2 displays a zoomed in map of the eastern POI locations. For the purposes of the EA's land use compatibility analysis, outdoor DNL was computed for every POI. The DNL results at each POI location are displayed in Section 5.

Table 2-1. Points of Interest for the Noise Analysis

Point of Interest				
Type	ID	Description	Latitude (deg N)	Longitude (deg W)
Hospitals	H01	St. Vincent Healthcare	45.79375	108.51887
	H02	Billings Clinic Hospital	45.79028	108.51272
Library	L01	Billings Public Library	45.78573	108.50969
Prison	O01	Montana Women's Prison	45.77498	108.49584
Parks	P01	Zimmerman Park	45.80621	108.60171
	P02	Poly Vista Park	45.79344	108.61379
	P03	Hilands Golf Club	45.79411	108.53643
	P04	Swords Park	45.79926	108.50824
	P05	Dehler Park	45.79109	108.51092
Residential	R01	Prairie Tower Apartments	45.789	108.50759
	R02	Sage Tower Retirement Apartments	45.78528	108.50114
	R03	Rifle Creek Trail Community	45.81352	108.59201
	R04	Masterson Circle Community	45.80397	108.57688
	R05	Wyatt Circle Community	45.80401	108.58403
	R06	Stoney Ridge Circle Community	45.802828	108.57297
	R07	Sky Ranch Community	45.803526	108.57039
Schools	S01	Poly Drive Elementary School	45.7947	108.57694
	S02	Rocky Mountain College	45.79664	108.55769
	S03	McKinley Elementary School	45.78655	108.51648
	S04	Rimrock Learning Center	45.79827	108.54954
	S05	Highland Elementary School	45.79062	108.53483
	S06	Billings Senior High School	45.78518	108.52685
	S07	Montana State University Billings	45.79772	108.52168
	S08	Billings Central Catholic High School	45.77801	108.51599
	S09	Orchard Elementary School	45.76793	108.5163
	S10	Riverside Middle School	45.76586	108.51105
	S11	Arrowhead Elementary School	45.79571	108.61274
Places of Worship	W01	Trinity Lutheran Church	45.78449	108.53016
	W02	First Baptist Church	45.77992	108.51491
	W03	St. Nicholas Orthodox Church	45.7813	108.52575
	W04	First Christian Church	45.78552	108.51134
	W05	American Lutheran Church	45.78146	108.5158
	W06	First Congregational United Church	45.78458	108.50688
	W07	St Patrick Co Cathedral	45.78198	108.51054
	W08	First English Lutheran Church	45.79339	108.52172

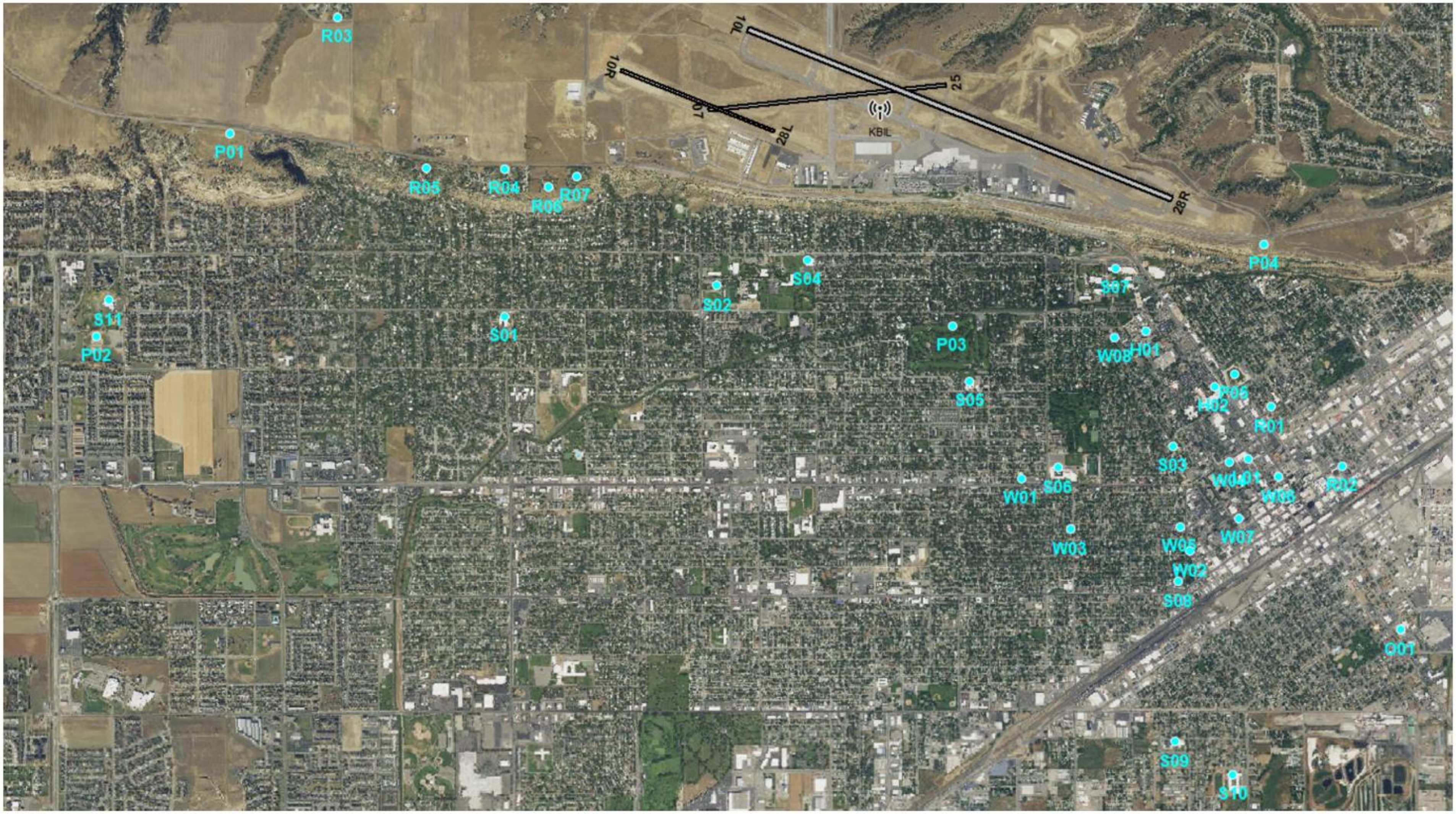


Figure 2-1. Map of the POI Locations

Figure 2-2. Zoomed-in Map of the East POI Locations

2.2 Noise Modeling and Installation/Airport Primary Noise Metrics

This noise study was conducted in accordance with the EA to assess the potential environmental impacts of adding the MTARNG helicopter operations to the proposed LAASF Billings location. The basis of this proposal is to preserve the operational capability of an airfield while protecting the communities surrounding an airfield. The Federal Interagency Committee on Urban Noise (FICUN), formed in 1979, published "Guidelines for Considering Noise in Land-Use Planning and Control." [1] These guidelines complement federal agency criteria by providing for the consideration of noise in all land-use planning and interagency/intergovernmental processes. The FICUN-established DNL is the most appropriate descriptor for all aircraft noise sources.

2.2.1 Day/Night Average Sound Level, DNL or Ldn

In 1982, the Environmental Protection Agency (EPA) published "Guidelines for Noise Impact Analysis" to provide all types of decision-makers with analytic procedures to uniformly express and quantify noise impacts. [2] The American National Standards Institute (ANSI) endorsed DNL in 1990 as the "acoustical measure to be used in assessing compatibility between various land uses and outdoor noise environment." [3] In 1992, the Federal Interagency Committee on Noise reaffirmed the use of DNL as the principal aircraft noise descriptor in the document entitled "Federal Agency Review of Selected Airport Noise Analysis Issues." [4] In general, scientific studies and social surveys have found a high correlation between the percentages of groups of people highly annoyed and the level of average noise exposure measured in DNL [5, 6, 7].

A noise metric refers to a unit or quantity that measures an aspect of the received noise and as such, noise metrics are used in environmental noise analyses. A metric is used to relate the received noise to its various effects. To quantify these effects, the Department of Defense (DoD) uses a series of metrics to describe the noise environment. These metrics range from simple to complex measures of the noise environment. However, for an EA or an Environmental Impact Statement (EIS) noise study, the DNL metric is used to describe the long-term noise environment on the airfield and in the surrounding communities.

DNL is a complex metric that sums the Sound Exposure Levels (SEL) of all noise events in a 24-hour period. An additional 10 dB is applied to nighttime events to account for the added intrusiveness of sounds that occur during normal sleeping hours, both because of the increased sensitivity to noise during those hours and because ambient sound levels during nighttime are typically about 10 dB lower than daytime hours.

DNL is an average quantity mathematically representing the continuous A-weighted sound level (weighting to account for the relative loudness perceived by the human ear) that would be present if all of the variations in sound level that occur over a 24-hour period were smoothed out so as to contain the same total sound energy. DNL accounts for the maximum noise levels, the duration of the events (operations), the number of events and the timing of their occurrence over a 24-hour period. DNL does not represent the sound level heard at any particular time, but it quantifies the total sound energy received. While it is normalized as an average, it represents all of the sound energy and is therefore a cumulative measure.

Although DNL provides a single measure of the overall noise impact, it does not provide specific information on the number of noise events or the individual sound levels that occur during the 24-hour period. For example, a daily average sound level of 65 dB could result from only a few loud events or many relatively quiet events. The FICUN guidance [1] characterizes aircraft noise exposure of DNL 55 to 65 dBA in residential areas as "moderate", DNL 65 to 75 dBA in residential areas as "significant" and DNL 75 dBA or more as "severe."

2.2.2 Maximum Sound Level (L_{Amax})

The highest A-weighted integrated sound level measured during a single noise event in which the sound level changes value with time (e.g., an aircraft overflight) is called the maximum A-weighted sound level (L_{Amax}). During an aircraft overflight, the noise level starts at the ambient or background sound level, rises to the maximum level as the aircraft flies closest to the observer, and returns to the background level as the aircraft recedes into the distance. L_{Amax} indicates the maximum sound level occurring for a fraction of a second during the event. For aircraft noise, the "fraction of a second" over which the maximum level is defined is generally 1/8th of a second. The maximum sound level is important in judging the interference caused by a noise event with conversation, TV listening, sleep, or other common activities. Although it provides some measure of the intrusiveness of the event, it does not completely describe the total event, because it does not include the period of time over which the sound is heard.

2.2.3 Sound Exposure Level (SEL)

SEL is a metric that represents both the intensity of a sound and its duration. Individual time-varying noise events (e.g., aircraft overflights) have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. SEL provides a measure of the net exposure of the entire acoustic event, but it does not directly represent the sound level heard at any given time. During an aircraft flyover, SEL would include both the maximum sound level and the lower sound levels produced during onset and recess periods of the overflight.

SEL is a logarithmic measure of the total acoustic energy transmitted to the listener during the event. Mathematically, it represents the sound level of a constant sound that would, in one second, generate the same acoustic energy as the actual time-varying noise event. For sound from aircraft overflights, which typically last more than one second, the SEL is usually greater than the L_{Amax} because an individual overflight takes seconds and the L_{Amax} occurs in a fraction of a second. SEL also provides the best measure to compare noise levels from different aircraft and/or operations. For aircraft noise, the SEL metric utilizes A-weighting.

2.2.4 Residential Nighttime Sleep Disturbance

For sleep disturbance, the DoD guidelines recommend the methodology and standard developed by American National Standards Institute (ANSI) and the Acoustical Society of America (ASA) in 2008 to compute the probability of awakening (PA) adults associated with outdoor noise events heard in homes and is a function of indoor SEL [8] [9] [10]. However, it is noted that this standard has been withdrawn, but it will be used until further recommendations are made by FICAN. SEL only pertains to flight events so PA is only applied to flight events and not run-up events. The ANSI methodology is valid from an indoor SEL of 50 dBA to a maximum SEL of 100 dBA. The resulting PA range for a single aircraft flight event is approximately 1% to 7.5%, respectively. Only DNL nighttime (2200-0700) flight events were considered. All POI were included because of their typical proximity to residential areas. PA was computed with AAD events.

NMAP computes outdoor noise levels which must be converted to interior noise levels by accounting for the noise attenuation provided by the structure (e.g., house or school) dependent upon whether windows are open or closed. The noise attenuation is known as Noise Level Reduction (NLR). Per FICON guidance, NLRs of 15 dB and 25 dB were used to account for the effect of a typical home with windows open and windows closed, respectively [11].

2.3 Computerized Noise Exposure Models

Analyses of aircraft noise exposure around military airfield facilities are normally accomplished by using the NoiseMap program [12]. NoiseMap is a suite of computer programs that were developed by the US Air Force, which serves as the lead DoD agency for fixed-wing aircraft noise modeling. NoiseMap allows noise predictions without the actual implementation of the operations and noise monitoring of those actions.

The latest NoiseMap package of computer programs consists of BaseOps Version 7 [13], OMEGA10, OMEGA11 [14], NoiseMap Version 7.3a [15] [16], NMPlot [17], and the latest issue of NOISEFILE. NOISEFILE is the DoD noise database originating from noise measurements of controlled flyovers at prescribed power, speed, and drag configurations for many models of aircraft. The data input module BaseOps allows the user to enter the runway coordinates, airfield information, flight tracks, and flight profiles along each track by each aircraft, numbers of flight operations, run-up coordinates, run-up profiles, and run-up operations. After the operational parameters are defined, NoiseMap calculates DNL values on a grid of ground locations on and around the facility. The NMPlot program draws contours of equal DNL for overlay onto land-use maps. For noise studies, as a minimum, DNL contours of 65, 70, and 75 dB are developed. NoiseMap also has the flexibility of calculating sound metrics (e.g., SEL, $L_{eq,24hr}$, and DNL) at specified points so that noise values at representative locations around an airfield can be described in more detail.

NoiseMap is most accurate for comparing "before-and-after" community noise effects, which would result from the implementation of proposed changes or alternative noise control actions when the calculations are made in a consistent manner. NoiseMap allows predicting noise levels for the proposed action prior to implementing and noise monitoring of the action. The noise modeling results of these computer programs, along with noise impact guidelines, provide a relative measure of noise effects around aircraft operating facilities.

3 FLIGHT TRACK AND FLIGHT PROFILE MODELING DATA DEVELOPMENT

3.1 Summary Flight Tracks

Tracks are represented by aircraft type (or group of aircraft), operation type, and runway. The proposed action MTARNG flight tracks were developed after the site visit through email exchanges with MTARNG pilots. The proposed MTARNG helicopter corridors for arrival and departure flights to/from the proposed LAASF hangar and the traffic pattern for closed pattern flights were developed by the MTARNG along with Billings Airport Air Traffic Control (ATC) input. The corridors are based on the Billings Airport Air Traffic Control, BFS, and MTARNG Letter of Agreement [18] landing and departing procedures. These corridors and traffic pattern are displayed in Figure 3-1. BRRC created arrival, departure, and closed pattern flight tracks based on the Coulson and Zimmerman corridors and the traffic pattern. The maps of these proposed MTARNG flight tracks were validated by MTARNG personnel and are depicted in this section.

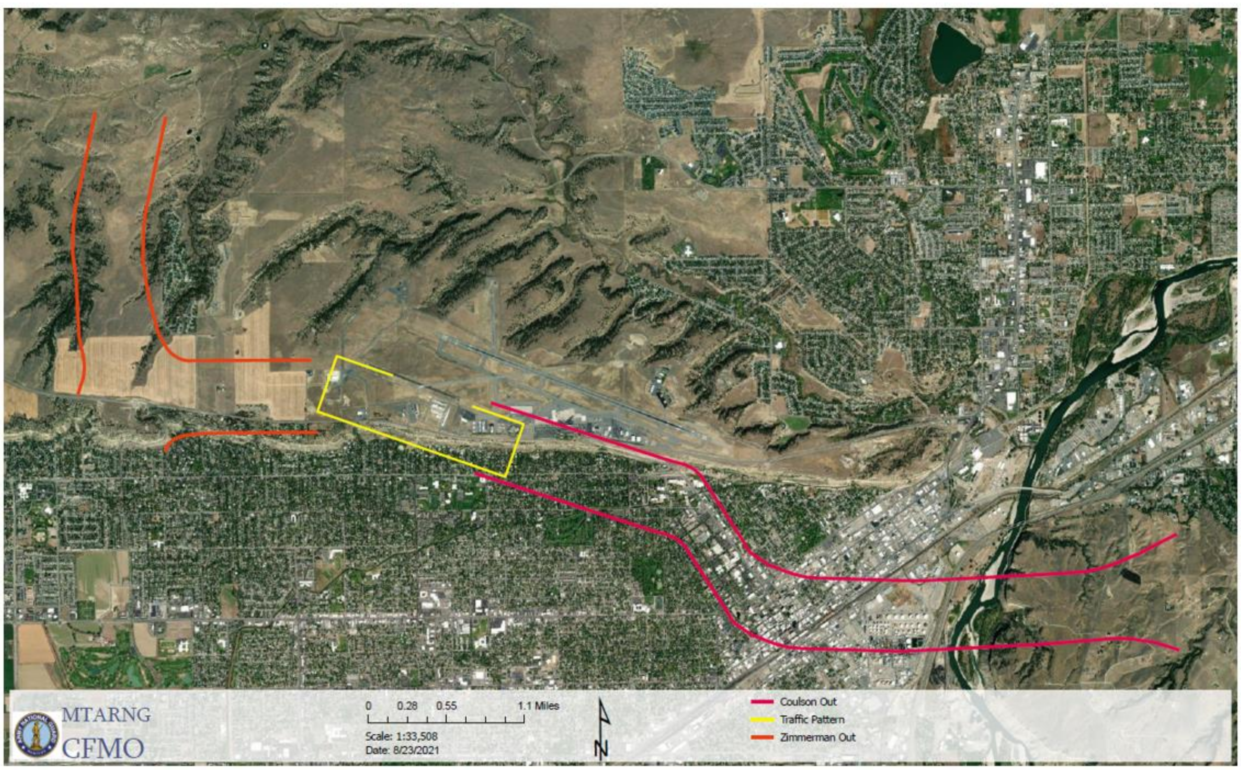


Figure 3-1. Proposed Action MTARNG Flight Corridors

The BFS helicopter flight tracks were derived from the Letter of Agreement corridor maps (attachments 1 and 2 in the helicopter operations Letter of Agreement) and are also displayed in this section.

The air carrier and general aviation (GA) aircraft flight tracks were derived from radar data of KBIL flight tracks provided by ATC. These radar data flight tracks were grouped by air carrier and GA aircraft separately and were grouped by each runway. BRRC created representative flight tracks based on the radar data, and those flight track maps were sent to ATC for review. ATC validated the air carrier/transient military and GA aircraft flight tracks as well as the associated flight track distributions that are displayed on each flight track.

The following subsections display the flight track graphics arranged by aircraft (Proposed Action MTARNG helicopters, BFS helicopters, civil air carrier and military transient aircraft, and GA aircraft), operation type (arrival, departure, and closed pattern) and helipad/runway (BFS pad, runways 10L, 10R, 28L, 28R, 07, and 25). The flight tracks are displayed as the blue lines in each figure. In addition to the summary track graphics depicted in this section, detailed graphics of each individual flight track modeled in the noise analysis for the Proposed Action MTARNG helicopters, BFS, and the baseline airport aircraft and helicopters are provided in Appendix A.

3.1.1 Proposed Action MTARNG Helicopter Flight Tracks

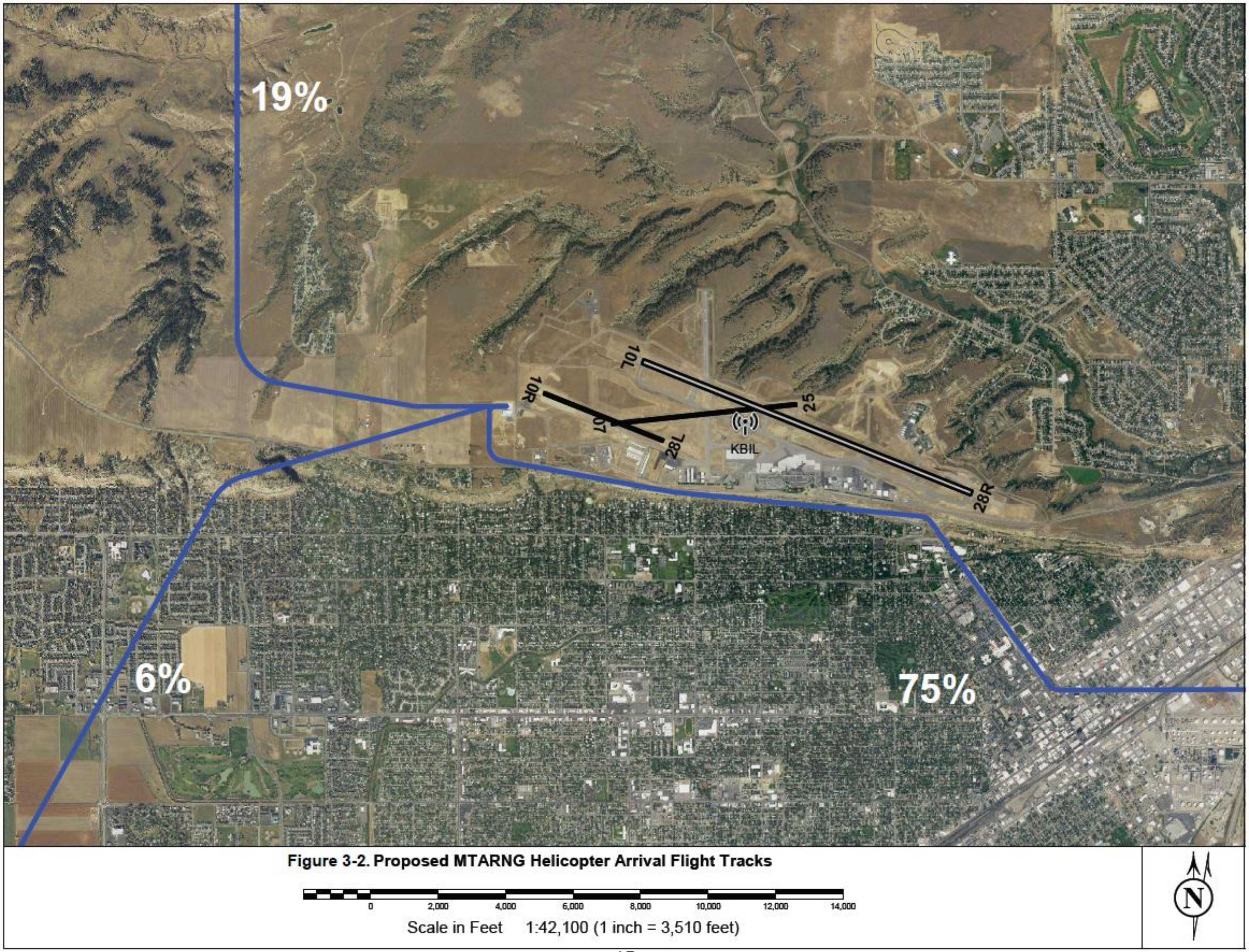
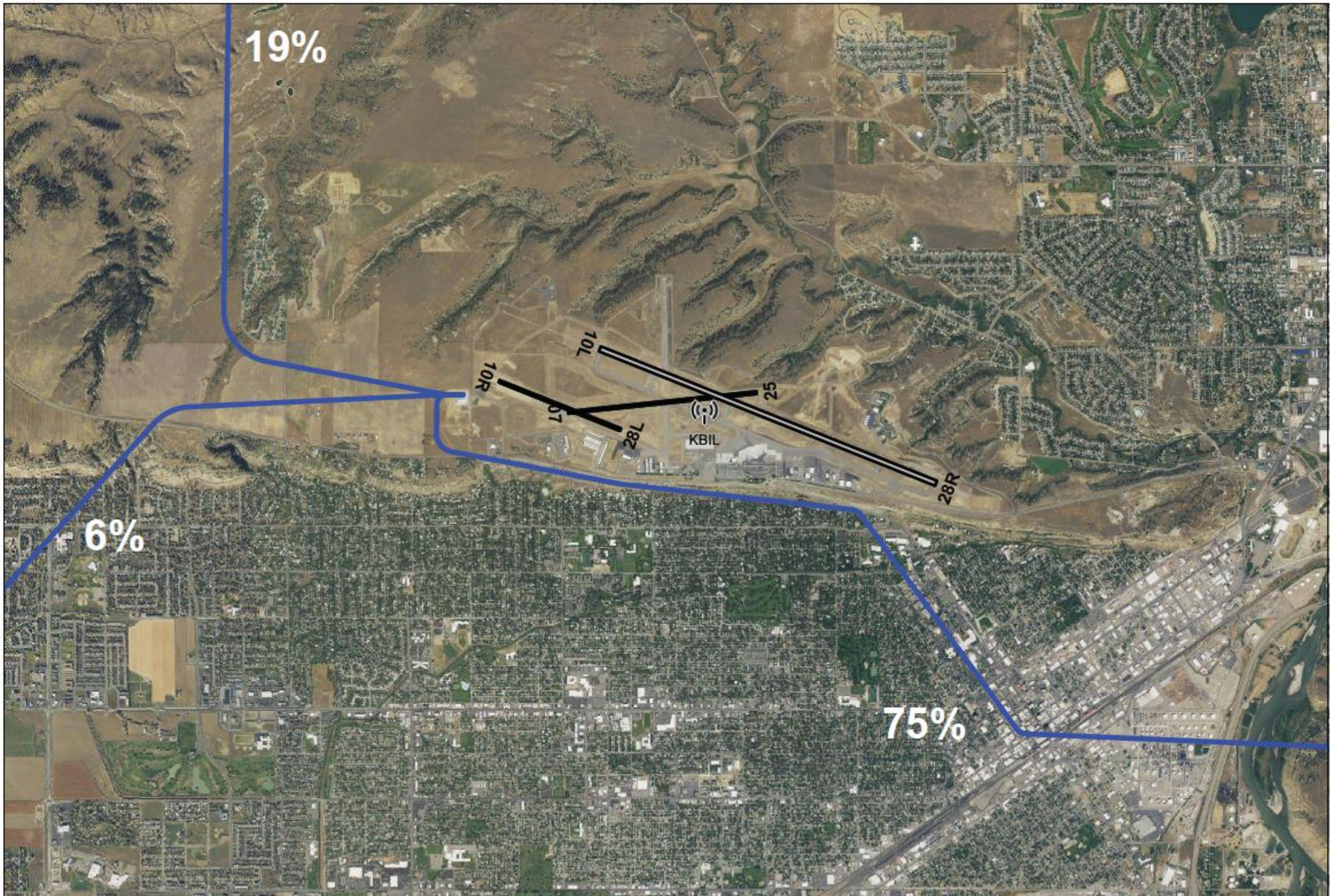


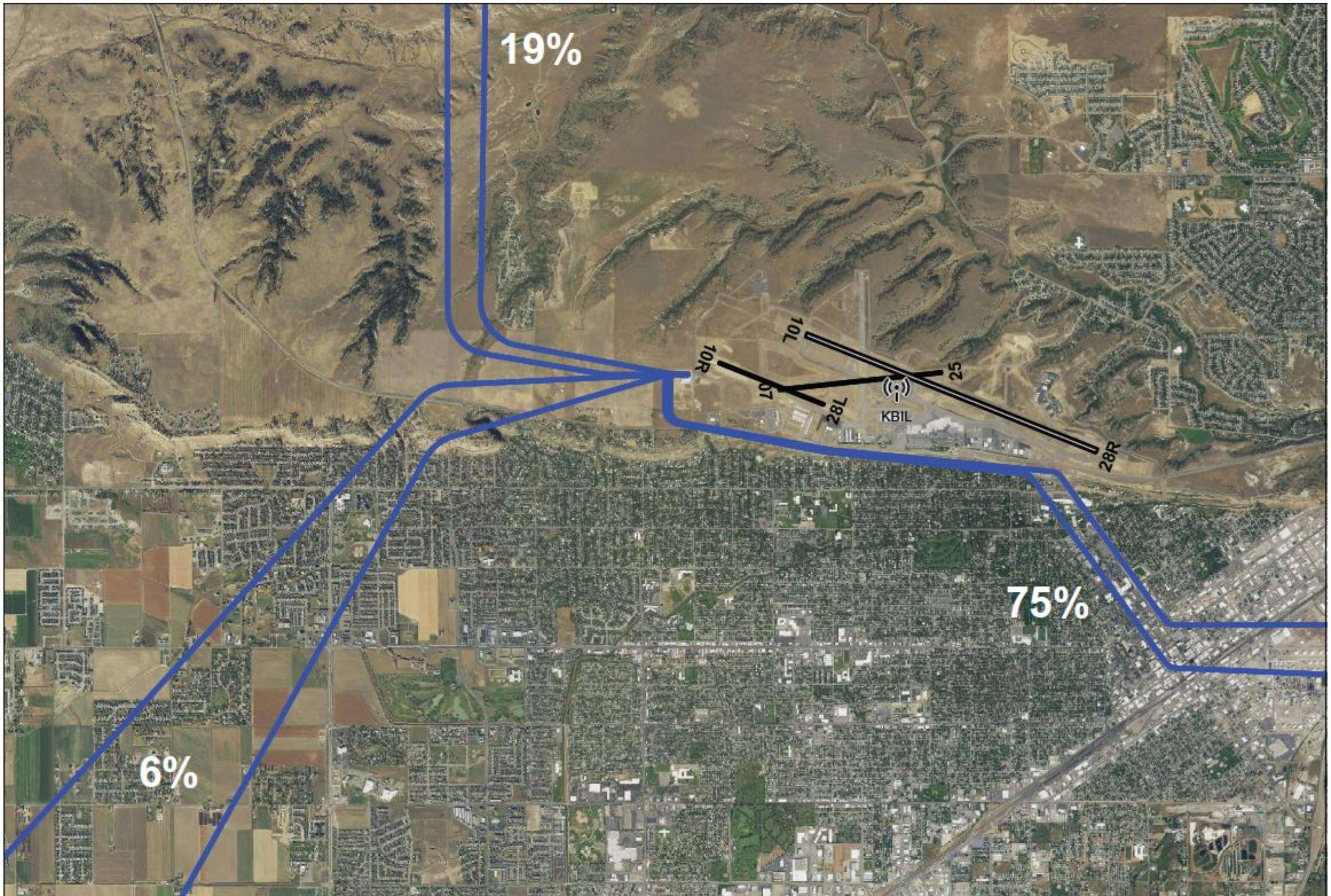
Figure 3-2. Proposed MTARNG Helicopter Arrival Flight Tracks



Proposed MTARNG Helicopter Departure Flight Tracks

0 2,000 4,000 6,000 8,000 10,000 12,000 14,000

Scale in Feet 1:43,900 (1 inch = 3,660 feet)



4: Proposed MTARNG Helicopter Arrival and Departure Flight Tracks

0 2,000 4,000 6,000 8,000 10,000 12,000 14,000 16,000

Scale in Feet 1:50,700 (1 inch = 4,230 feet)

N

□□□r□□□5□ **Proposed MTARNG Helicopter Closed Pattern Flight Track**

0 1,000 2,000 3,000 4,000 5,000

Scale in Feet 1:16,500 (1 inch = 1,370 feet)

3.1.2 Billings Flying Service Helicopter Flight Tracks

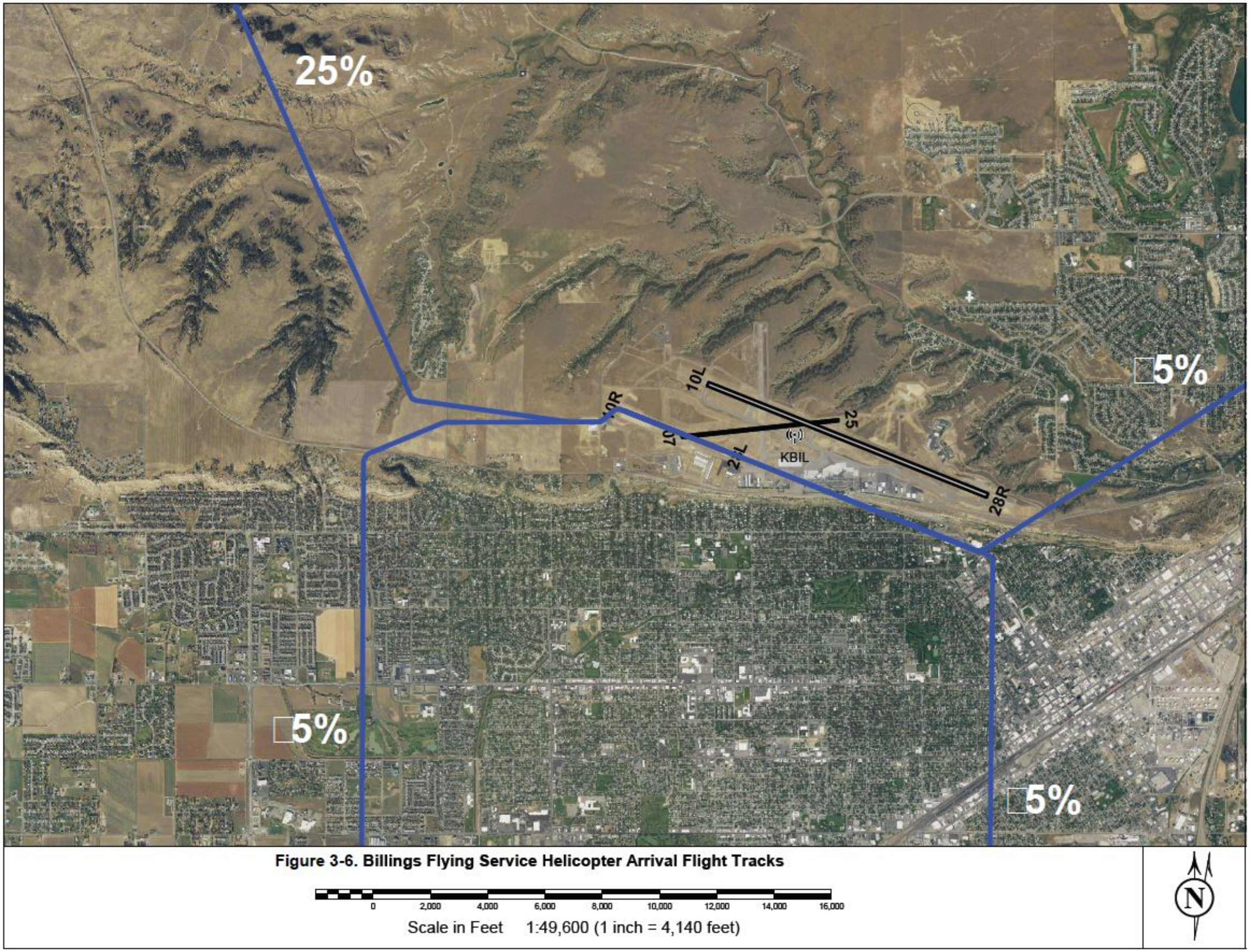
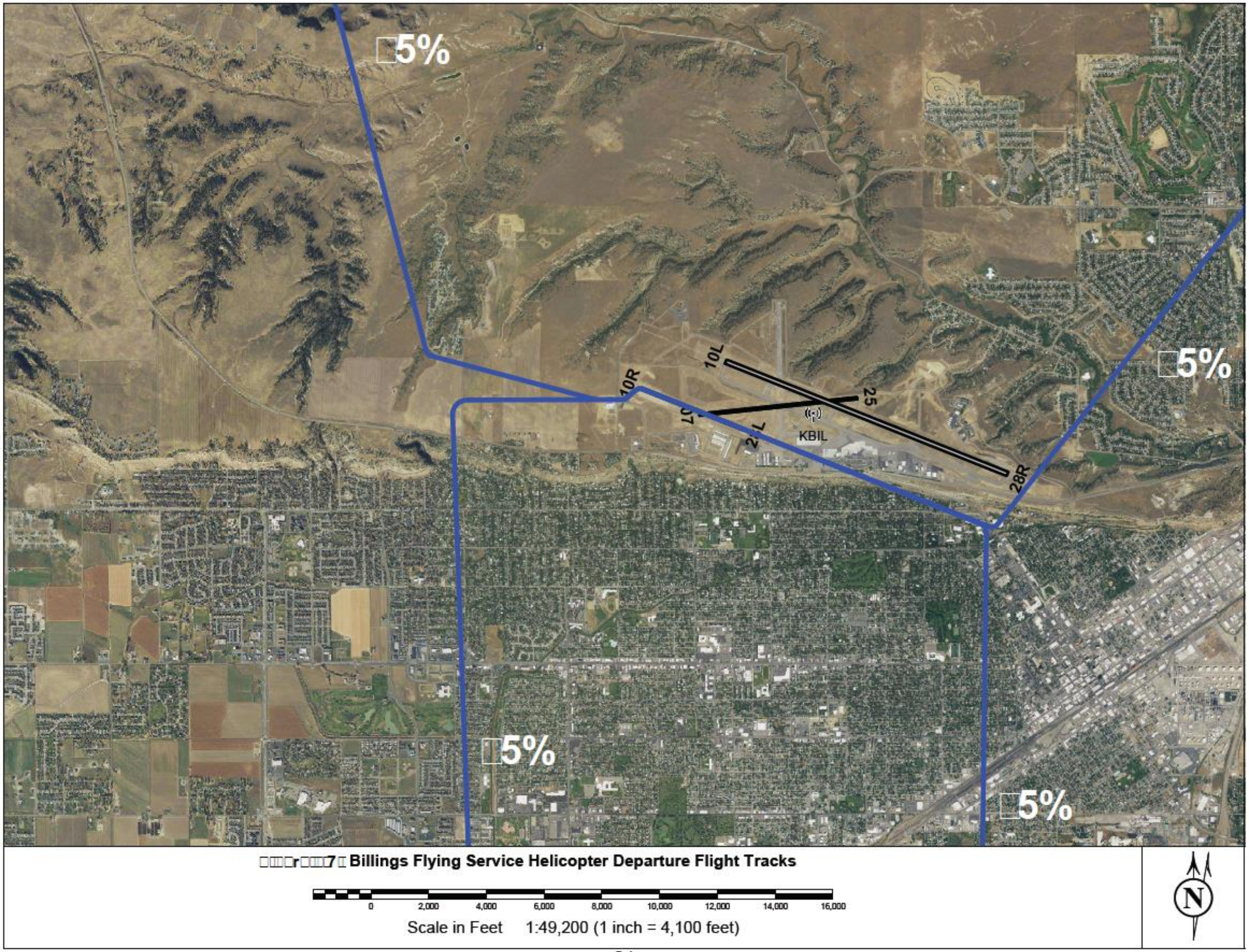


Figure 3-6. Billings Flying Service Helicopter Arrival Flight Tracks



□□□r□□□7 □ **Billings Flying Service Helicopter Departure Flight Tracks**

3.1.3 KBIL Civil Air Carrier and Transient Military Flight Tracks

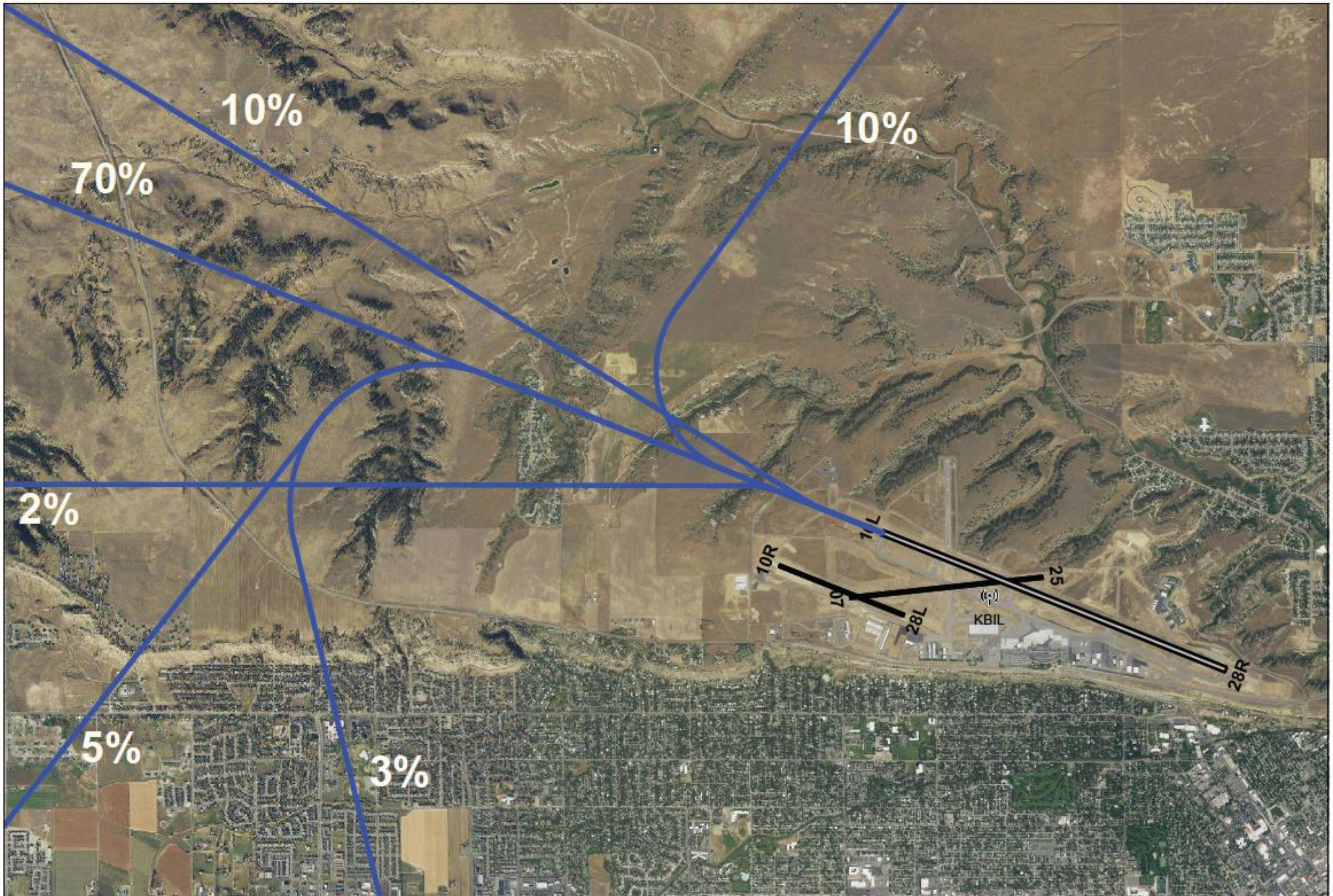


Figure 3-8. Billings Airport Runway 10L Air Carrier Arrival Tracks

0 2,000 4,000 6,000 8,000 10,000 12,000 14,000
Scale in Feet 1:43,000 (1 inch = 3,590 feet)

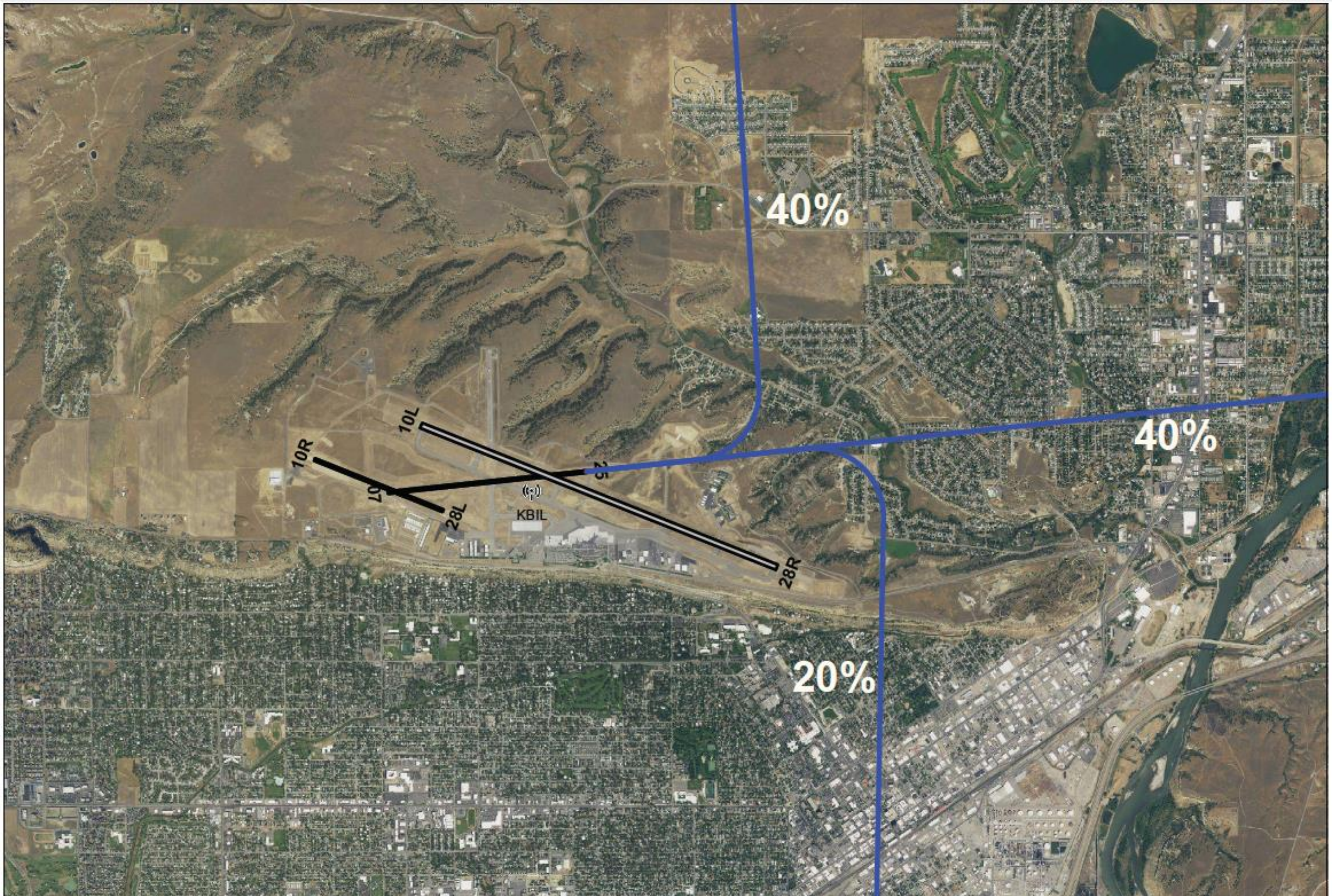
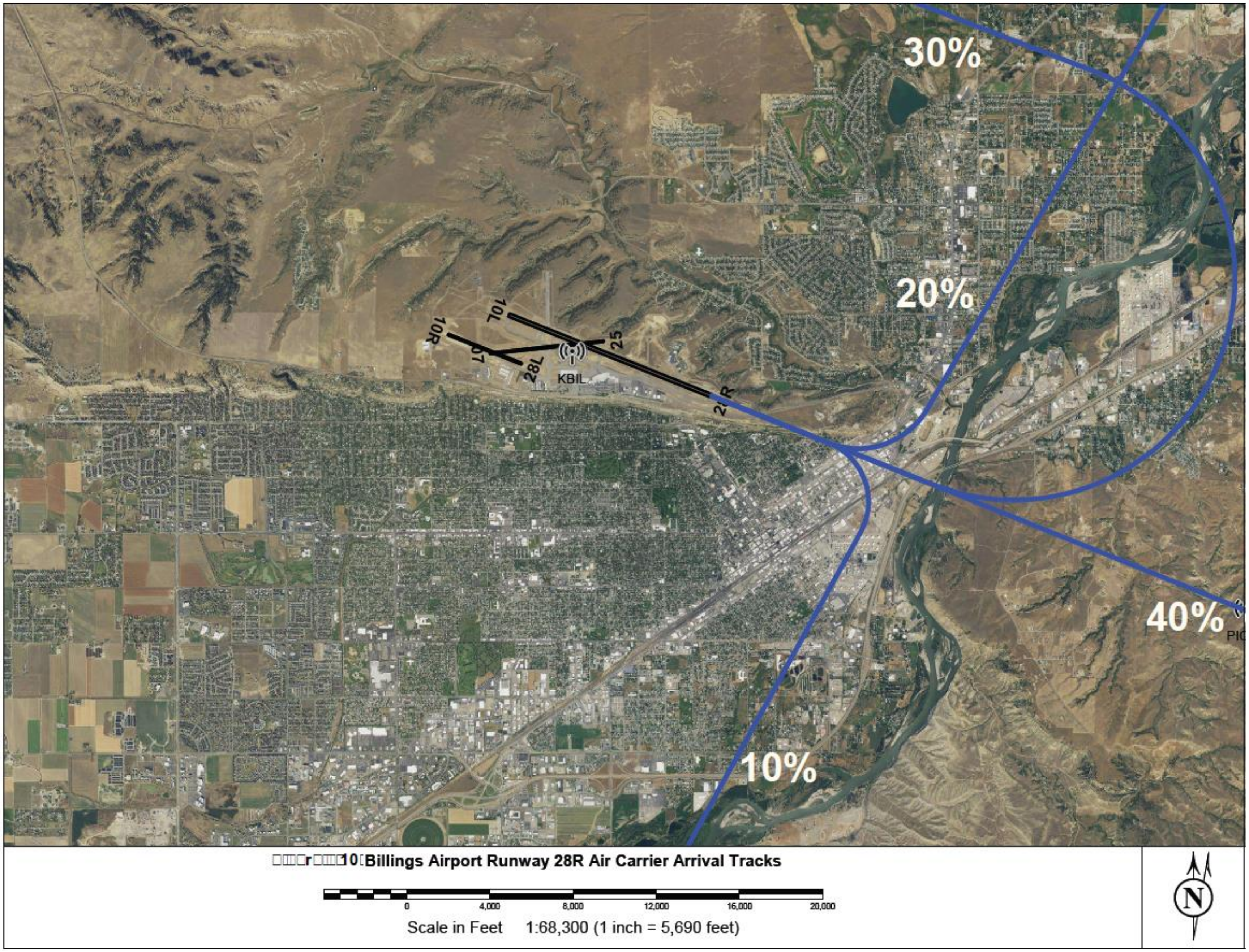


Figure 9: Billings Airport Runway 25 Air Carrier Arrival Tracks

0 2,000 4,000 6,000 8,000 10,000 12,000

Scale in Feet 1:41,500 (1 inch = 3,460 feet)

N



□□□r□□□10□Billings Airport Runway 28R Air Carrier Arrival Tracks

Scale in Feet 1:68,300 (1 inch = 5,690 feet)

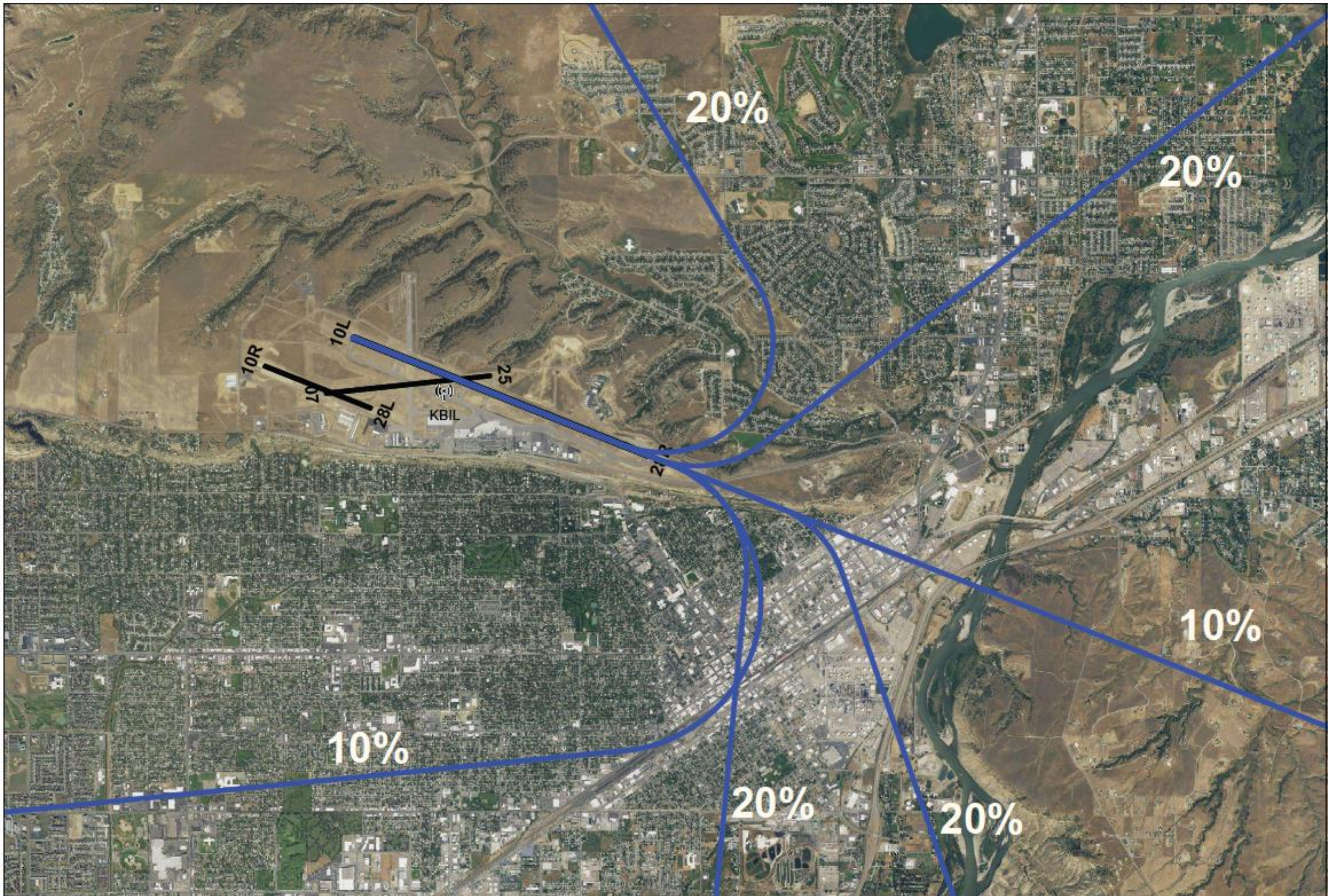


Figure 11 Billings Airport Runway 10L Air Carrier Departure Tracks

0 2,000 4,000 6,000 8,000 10,000 12,000 14,000 16,000

Scale in Feet 1:50,000 (1 inch = 4,170 feet)

N

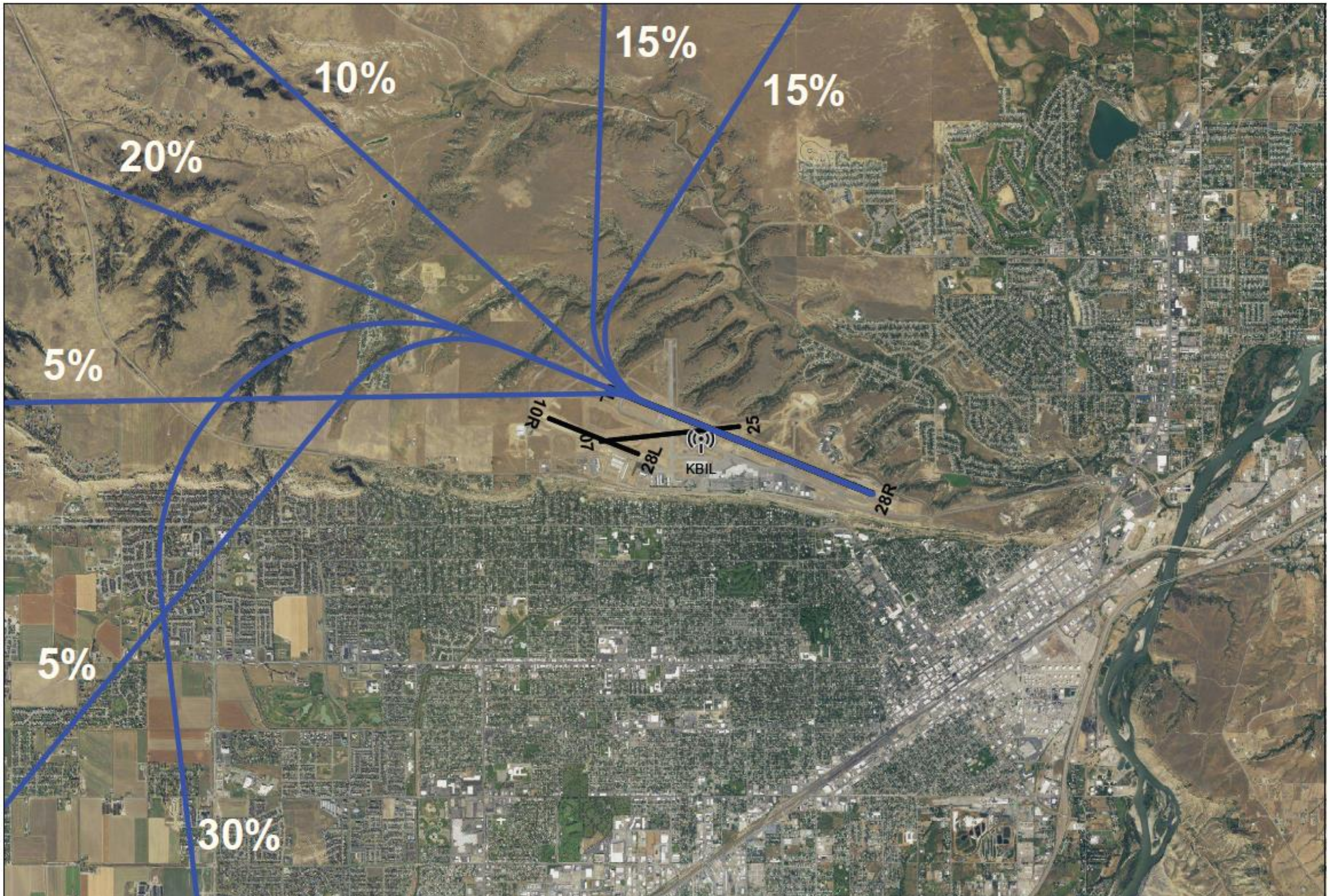


Figure 12: Billings Airport Runway 28R Air Carrier Departure Tracks

Scale in Feet 1:59,000 (1 inch = 4,920 feet)

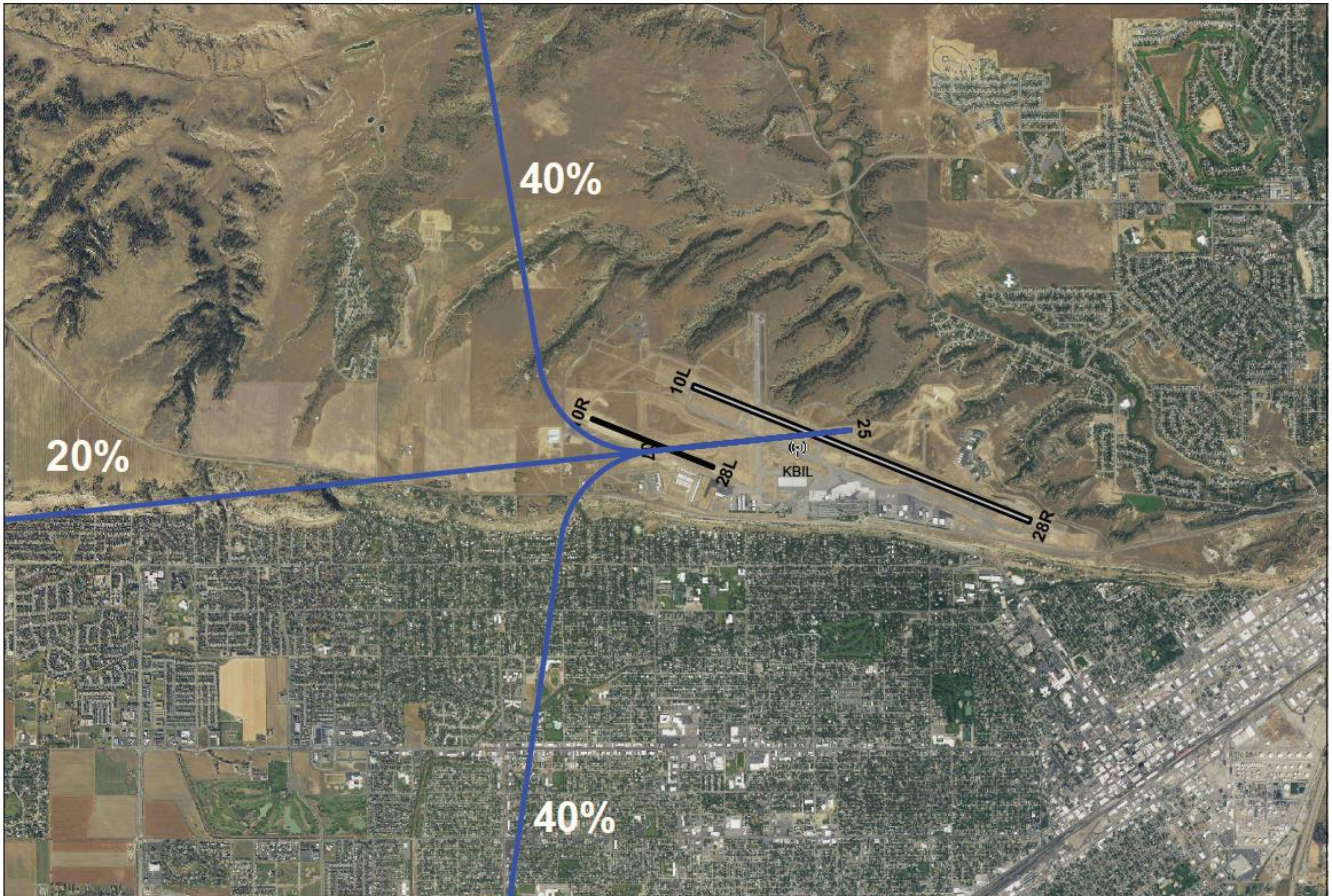


Figure 13: Billings Airport Runway 25 Air Carrier Departure Tracks

0 2,000 4,000 6,000 8,000 10,000 12,000 14,000

Scale in Feet 1:43,800 (1 inch = 3,650 feet)

N

3.1.4 KBIL GA Aircraft Flight Tracks

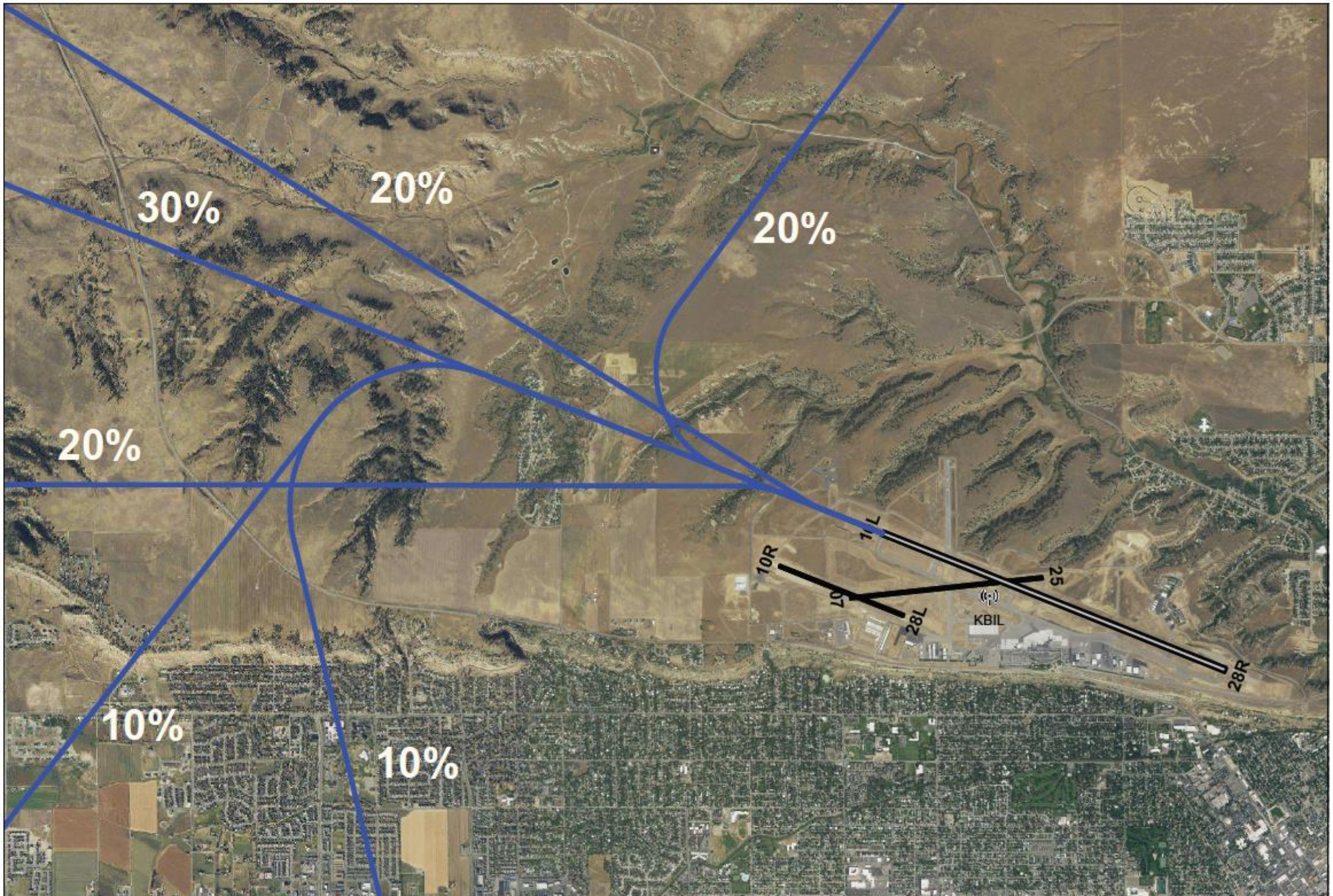
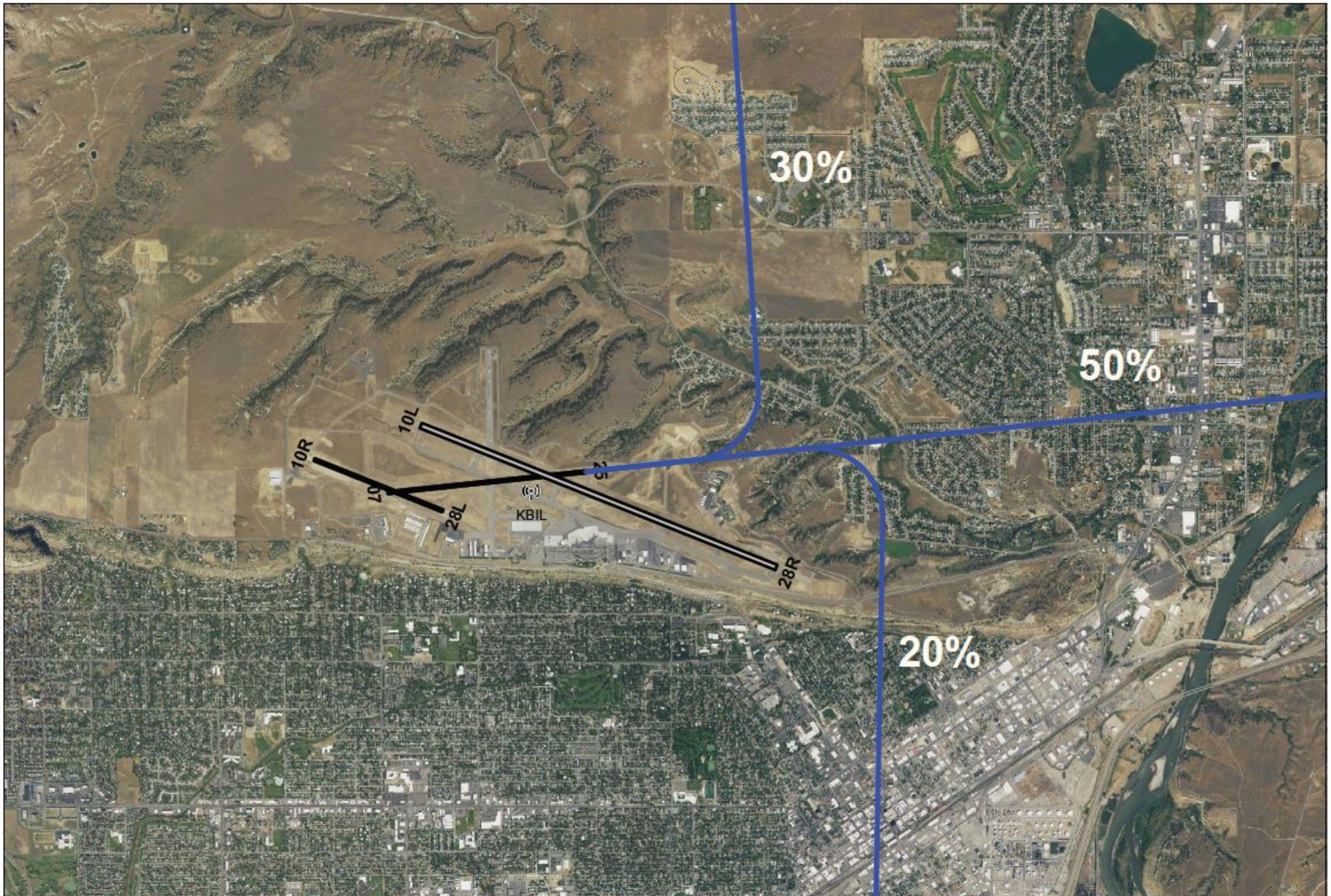


Figure 14. Billings Airport Runway 10L GA Aircraft Arrival Tracks

0 2,000 4,000 6,000 8,000 10,000 12,000 14,000

Scale in Feet 1:43,000 (1 inch = 3,590 feet)

Figure 15. Billings Airport Runway 07 GA Aircraft Arrival Tracks



□□□r□□□17□ Billings Airport Runway 25 GA Aircraft Arrival Tracks

0 2,000 4,000 6,000 8,000 10,000 12,000

Scale in Feet 1:41,500 (1 inch = 3,460 feet)

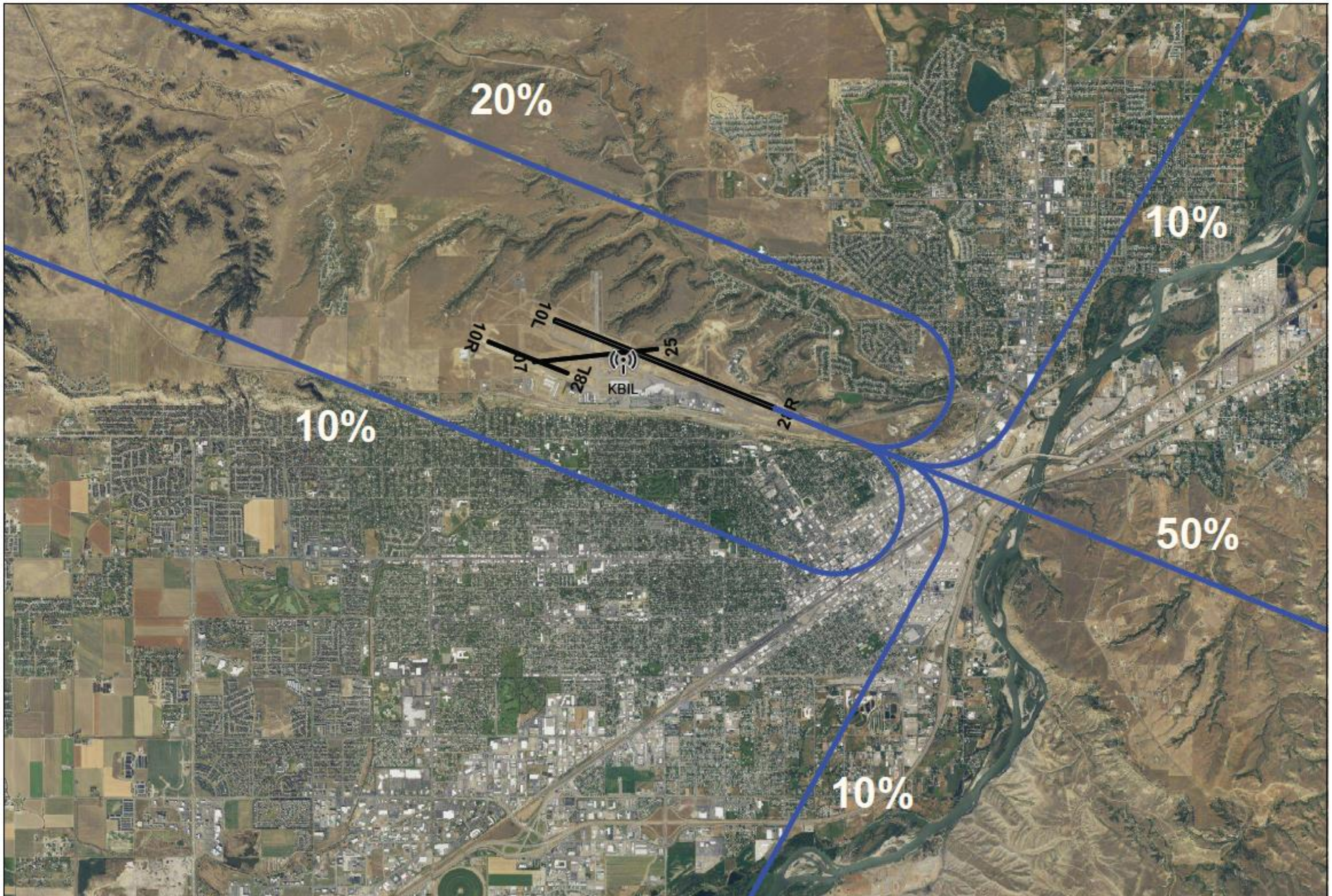


Figure 19: Billings Airport Runway 28R GA Aircraft Arrival Tracks

0 4,000 8,000 12,000 16,000 20,000

Scale in Feet 1:66,800 (1 inch = 5,560 feet)

N

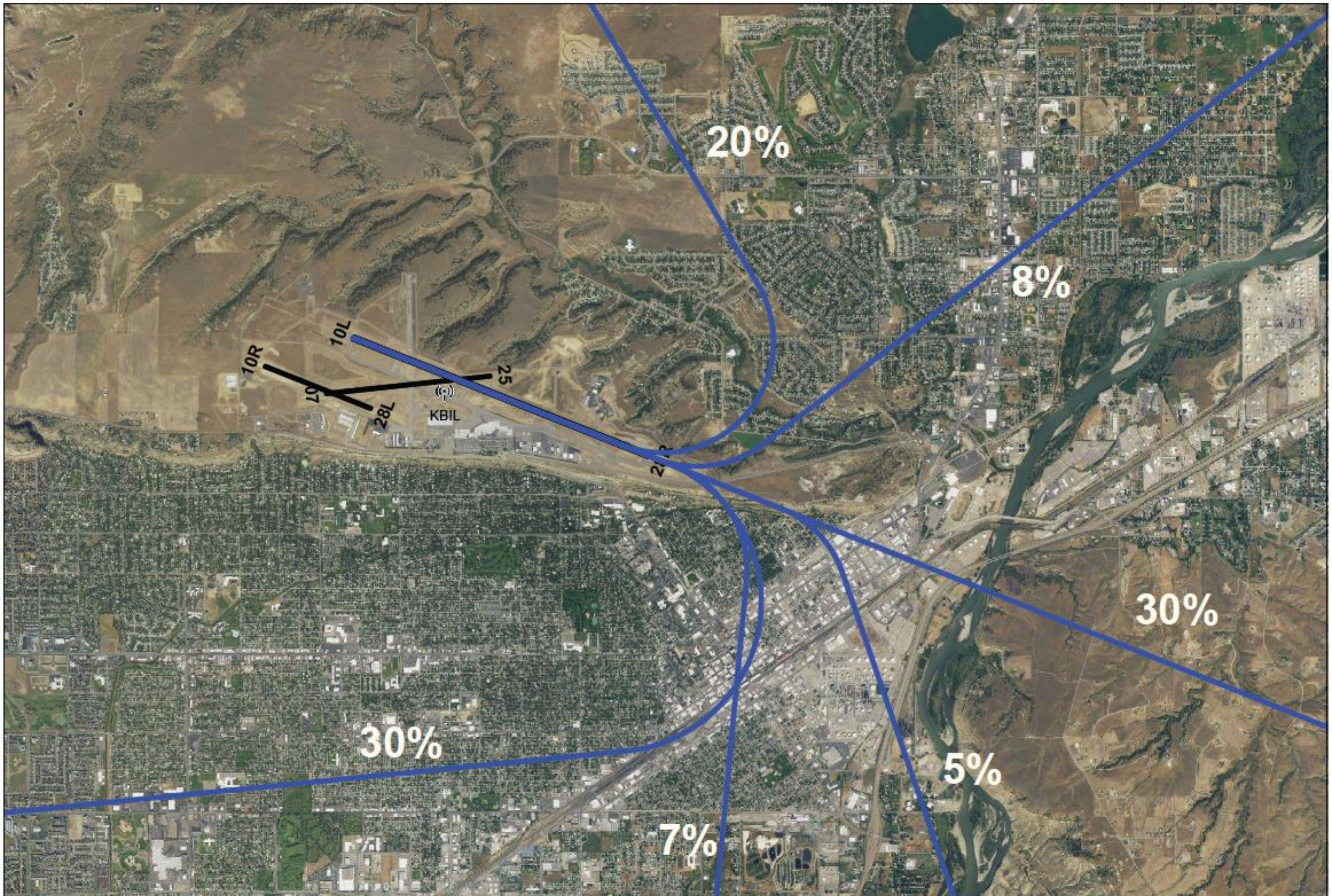
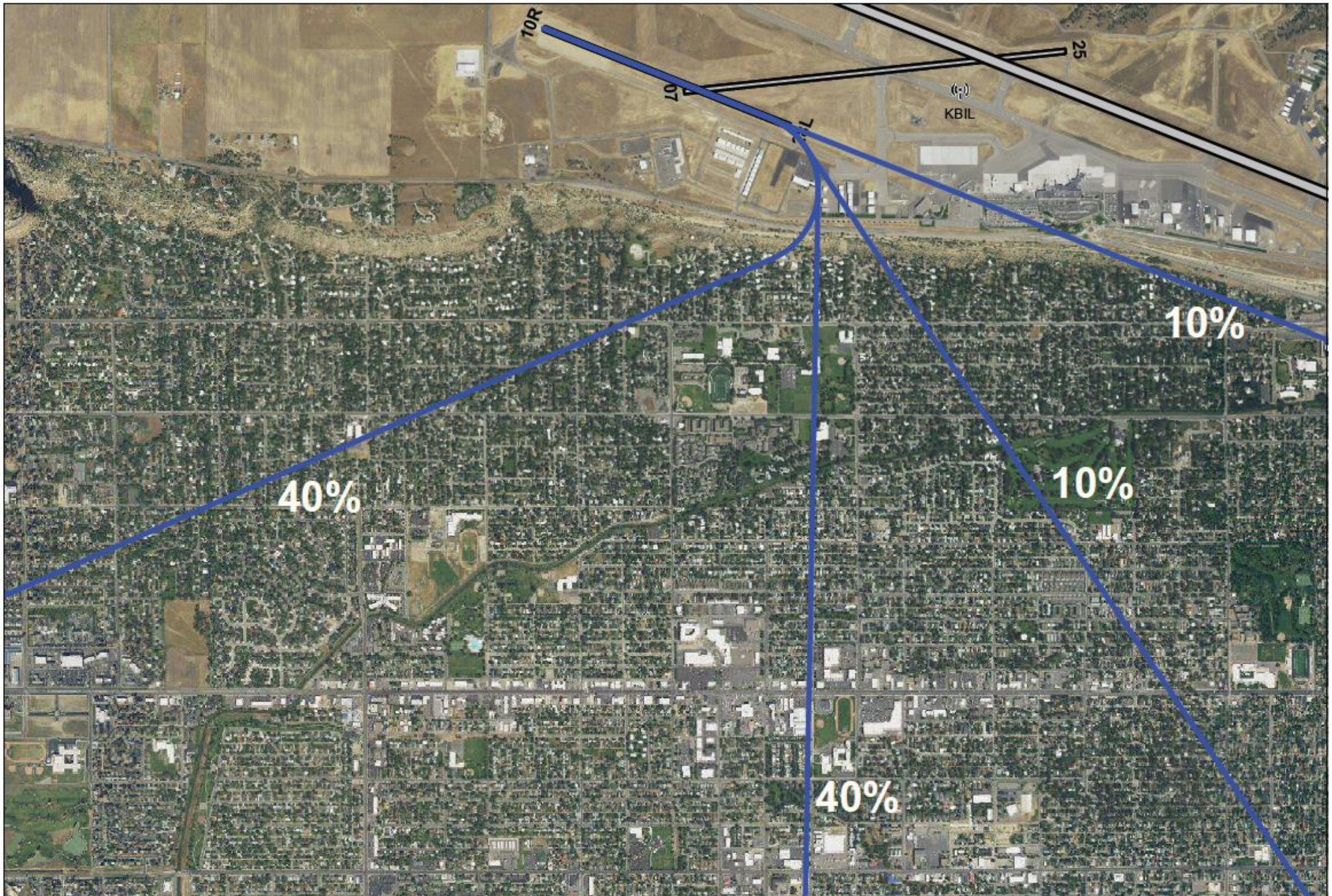


Figure 20 Billings Airport Runway 10L GA Aircraft Departure Tracks

0 2,000 4,000 6,000 8,000 10,000 12,000 14,000 16,000

Scale in Feet 1:50,000 (1 inch = 4,170 feet)

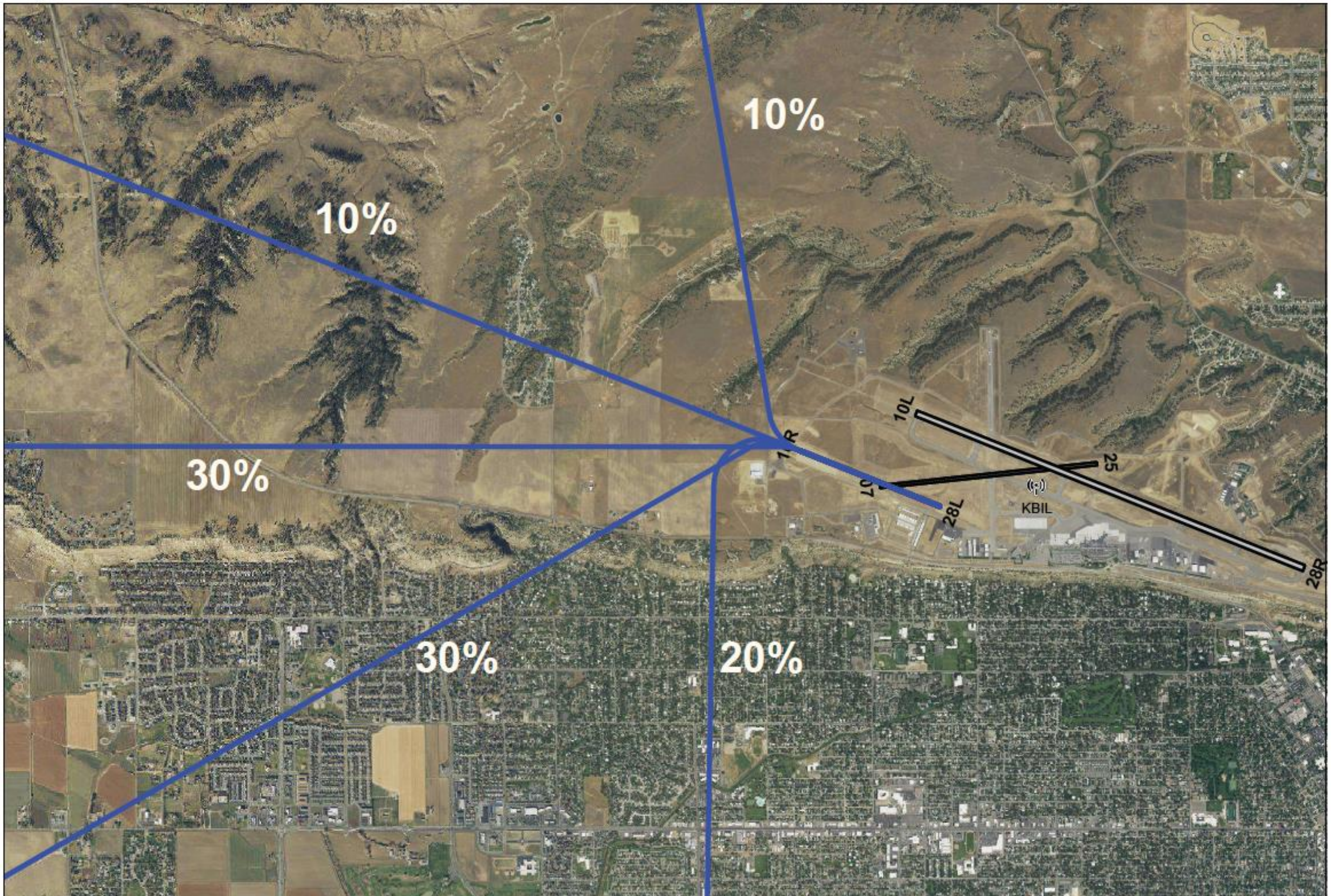


Billings Airport Runway 10R GA Aircraft Departure Tracks

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000

Scale in Feet 1:21,700 (1 inch = 1,810 feet)

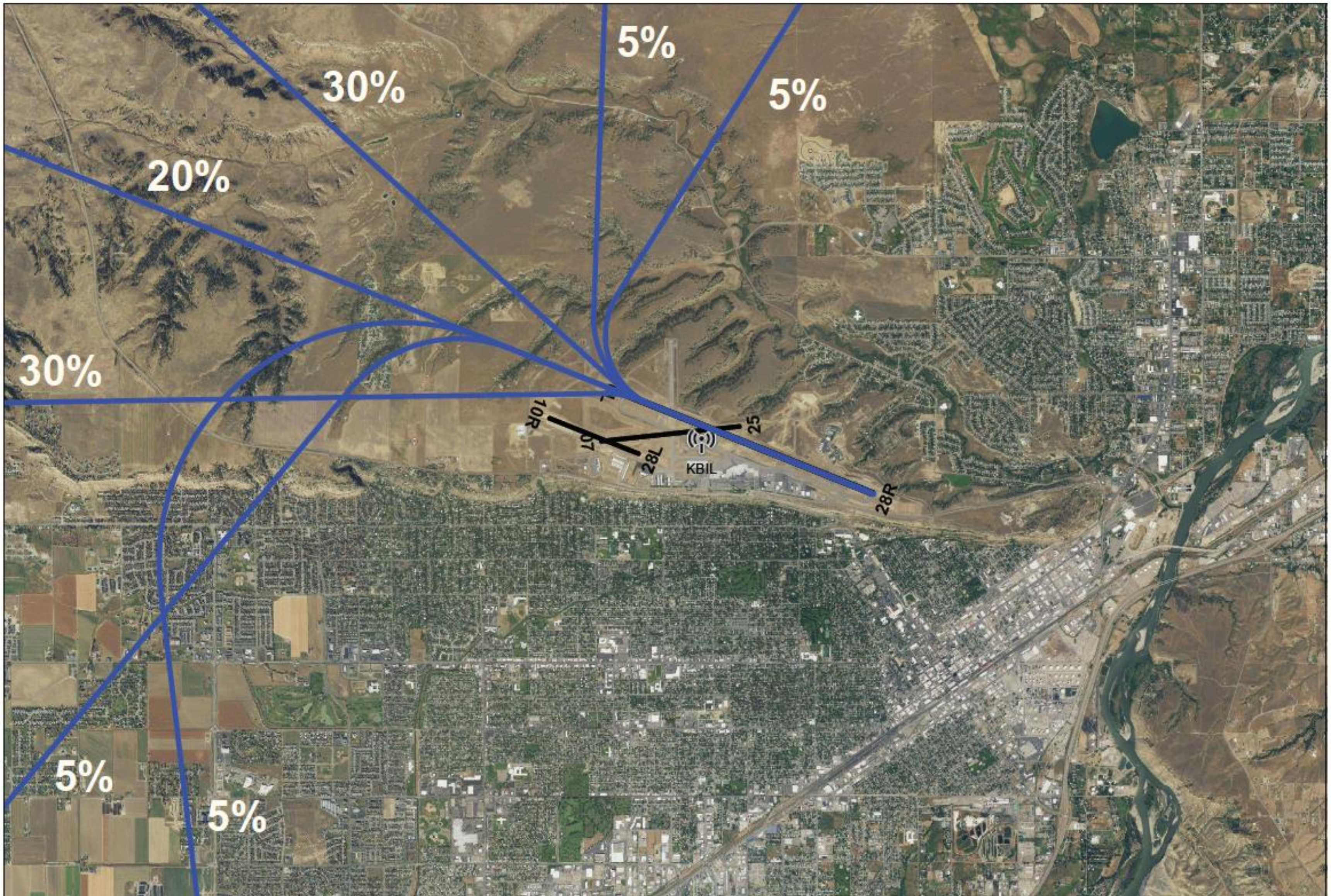
N



□□□r□□□□2□ Billings Airport Runway 28L GA Aircraft Departure Tracks

0 2,000 4,000 6,000 8,000 10,000 12,000

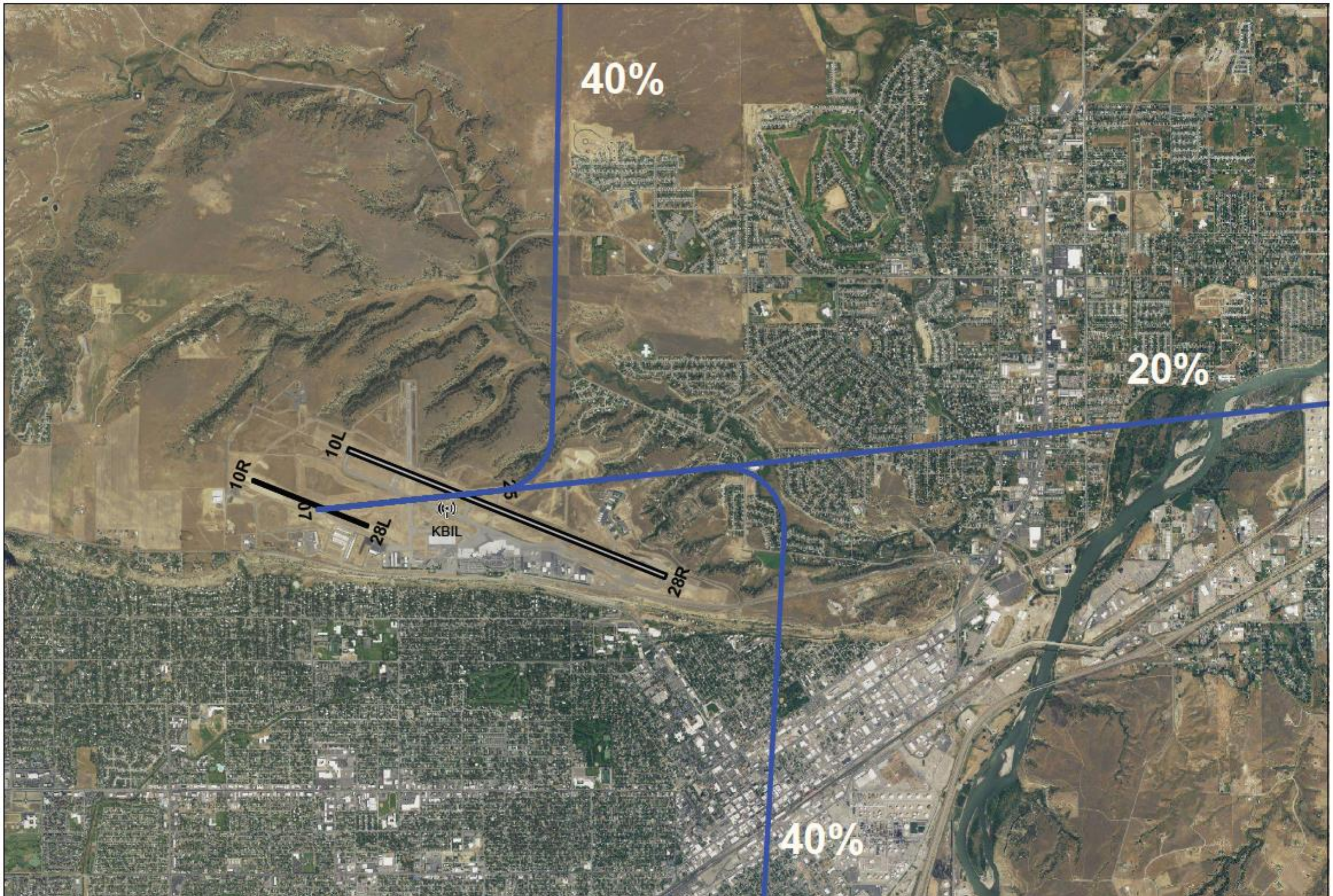
Scale in Feet 1:38,100 (1 inch = 3,170 feet)



Billings Airport Runway 28R GA Aircraft Departure Tracks

0 2,000 4,000 6,000 8,000 10,000 12,000 14,000 16,000 18,000 20,000

Scale in Feet 1:59,000 (1 inch = 4,920 feet)



□□□r□□□□4[Billings Airport Runway 07 GA Aircraft Departure Tracks

0 2,000 4,000 6,000 8,000 10,000 12,000 14,000

Scale in Feet 1:46,500 (1 inch = 3,880 feet)

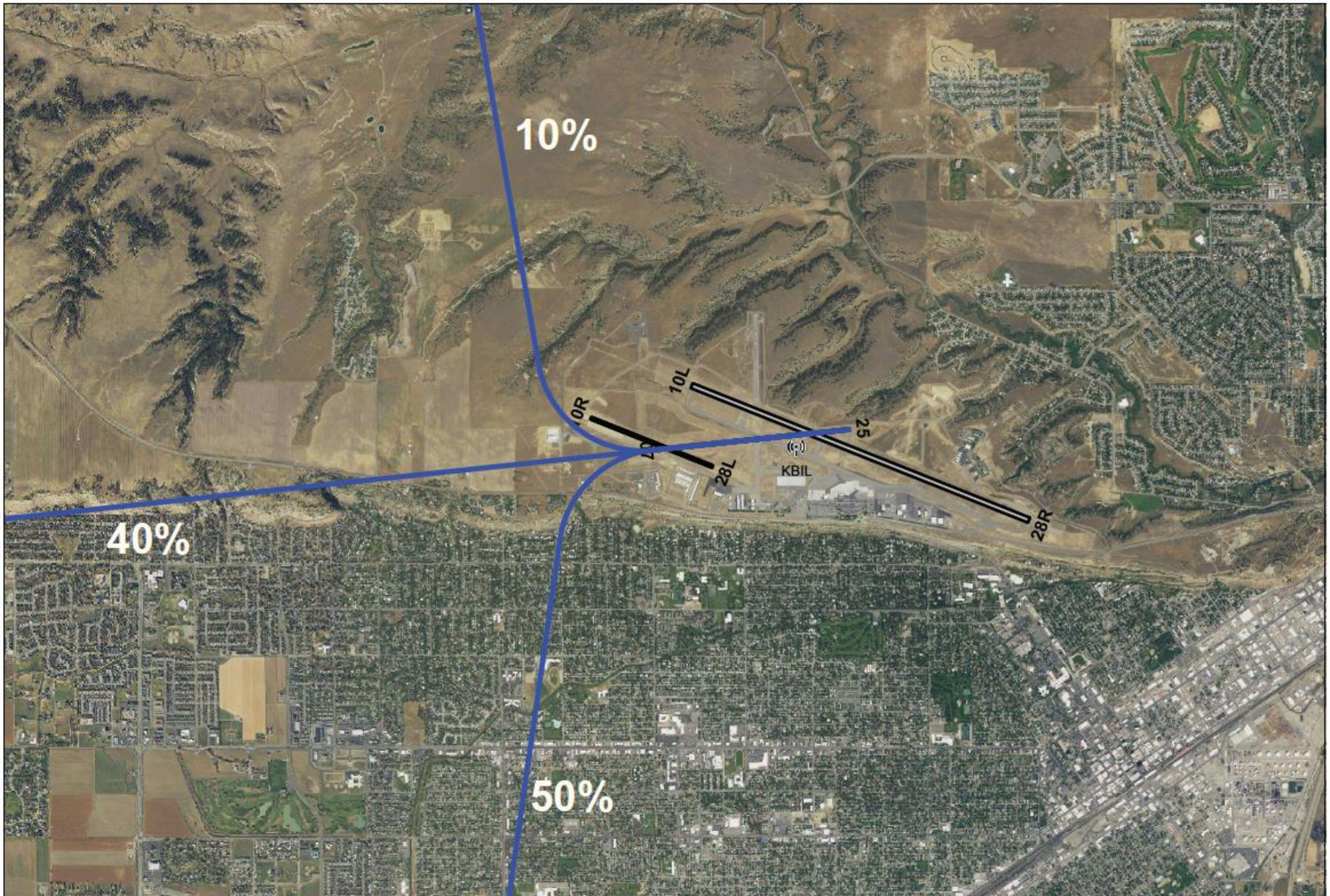


Figure 5. Billings Airport Runway 25 GA Aircraft Departure Tracks

0 2,000 4,000 6,000 8,000 10,000 12,000 14,000

Scale in Feet 1:43,800 (1 inch = 3,650 feet)

Figure 16 Billings Airport Runway 10L/28R GA Aircraft Closed Pattern Flight Tracks

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000

Scale in Feet 1:24,100 (1 inch = 2,010 feet)

Figure 7: Billings Airport Runway 10R/28L GA Aircraft Closed Pattern Flight Tracks

0 400 800 1,200 1,600 2,000 2,400 2,800 3,200 3,600 4,000 4,400 4,800 5,200

Scale in Feet 1:15,200 (1 inch = 1,270 feet)

N

3.2 Flight Profiles

The modeled MTARNG helicopter flight profiles were developed based on the on-site interviews with the MTARNG pilots. These discussions require an iterative process as the aircrews and modelers translate the flying parameters into the parameters utilized by the noise model. This iterative process ensures that the modeled flight profiles provide an accurate description of the aircrews' nominal flight procedures throughout the year. For the BFS helicopter flight profiles, the climb and descent rates, airspeeds, and cruise altitudes were modeled with the same parameters as the MTARNG helicopters. For the transient military aircraft at KBIL, the EA-18G and P-8 profiles were derived from the Whidbey Island EIS noise study [19], and the C-130J profiles were derived from the Fort Wayne EA Noise Study [20]. The KBIL civil aircraft flight profiles were derived from the standard profiles used in the FAA Aviation Environmental Design Tool (AEDT).

One representative flight profile for each operation type of the Proposed Action MTARNG helicopters, BFS helicopters, and each modeled civil and transient aircraft at KBIL are provided in Appendix B. Note that besides the Proposed Action MTARNG flight profiles, not all operational profiles are shown; rather, a representative profile on one flight track for each operation type is shown. Each figure includes a table of flight parameters describing the flight trajectory along the flight track. The altitude and airspeed parameters are varied linearly between the points denoted by the corresponding letter whereas engine power (for the fixed wing aircraft) changes occur at the discreet points. For departure and pattern profiles, the trajectories proceed as the aircraft flies. However, for arrivals, the trajectories are described in reverse. Please also note that some of the following profiles depicted have trajectories that extend beyond the map range.

It is important to note a few of the modeling parameters. First, the terms "Variable" and "Parallel" for fixed wing aircraft refer to noise interpolation codes that are used to distinguish between clean and "dirty" (landing gear extended) configurations, respectively, when the noise data are significantly different between the configurations for an individual aircraft.

3.3 Ground Run Ups

The only helicopter ground run-ups/engine runs planned for the Proposed Action LAASF are regular engine washes. It is expected that these engine wash run-ups would occur 10 times per year for the CH-47, 10 times per year for the UH/HH-60, and 8 times per year for the LUH-72. The location for these engine runs would be on the existing BFS helipad. One engine would be running at a time for a total of 10 minutes for the engine wash. The heading for these engine runs is expected to be 270 degrees. For the civil aircraft at KBIL, the fixed wing and helicopter run up locations are far enough away from the Proposed Action helipad and helicopter flight track locations that it would have no effect on the Proposed Action DNL or the difference between the No Action and the Proposed Action DNL results. Thus, no run ups were modeled for the KBIL civil aircraft and helicopters.

4 DEVELOPMENT OF FLIGHT OPERATION DISTRIBUTIONS

Assessment of airfield noise requires a range of data from many sources. These sources provide descriptions of the types, frequency, and location of noise-generating operations occurring at and around the airfields. For this noise study, the data sources include interviews with pilots, planners, schedulers, and air traffic controllers. The data from these sources are compiled and integrated into a description of the noise generating activities occurring at the airfield. The operational description includes the frequency of flight operations, operation types, airfield layout, runway utilization, and the temporal distribution of operations.

4.1 Annual Operations

For the No Action, current baseline activities at KBIL and BFS were analyzed. For the Proposed Action, the MTARNG helicopter operations were added to the baseline conditions. The helicopter, transient military and civil aircraft flight operations involve a variety of departure, arrival, and closed pattern procedures. Table 4-1 and Table 4-2 present the No Action and Proposed Action annual operations for the noise analysis. The total number of modeled aircraft operations (including BFS and transient military) at KBIL is 84,875 annual operations under the No Action Alternative and 86,290 annual operations under the Proposed Action. Not all civil aircraft types are available in the noise model, so the modeled aircraft type is displayed in parenthesis after the actual aircraft type. Note that the UH/HH-60 and CH-47 are modeled at the airport as part of the baseline airport and Billings Air Service helicopter ops, and separately the UH/HH-60 and CH-47 are modeled as part of the MTARNG Proposed Action. Both sets of helicopter operations are unrelated.

The two tables below provide the modeled flight operations as defined by the number of takeoffs and landings; therefore, closed patterns are counted as two flight operations because pattern procedures include both a landing and takeoff. Tabular aircraft operations data for each airfield are organized by aircraft, operation type, and sortie type where a sortie describes the specific flight mission of one aircraft.

Table 4-1. Billings International Airport No Action (Baseline) Annual Operations

Group	Sorties at Full Unit Strength	Unit / Description	# of Flying Days	Basis of Sorties (# of days)	Patterns per Sortie	Annual Departures	Annual Arrivals	Annual Closed Pattern Operations	Total Annual Operations
Civil and Transient Aircraft									
Bombardier Q400 (modeled as DHC-830)	na	Civil Aircraft	365	365		2001	2001		4002
Airbus A-319/A-320 (A320)	na	Civil Aircraft	365	365		2823	2823		5646
Embraer ERJ-175 (BAE-146)	na	Civil Aircraft	365	365		3502	3502		7004
Cessna 402 (Beechcraft Baron 58P)	na	Civil Aircraft	365	365		6503	6503		13006
Boeing 737-800 (B737-700)	na	Civil Aircraft	365	365		500	500		1000
Bombardier CRJ-550 (Bombardier CL-601)	na	Civil Aircraft	365	365		1501	1501		3002
Boeing 757-200 (B757-200-RR)	na	Civil Aircraft	365	365		572	572		1144
Airbus A-300-600 (A300)	na	Civil Aircraft	365	365		1001	1001		2002
Boeing 767 (B767-CF6)	na	Civil Aircraft	365	365		858	858		1716
GA Prop (GA Single Engine Variable Wing)	na	Civil Aircraft	365	365	0.5	10125	10125	10125	30375
Cessna 500	na	Civil Aircraft	365	365		602	602		1204
Beech Super King Air (C-12)	na	Civil Aircraft	365	365		377	377		754
H-60 (S70)	na	Helicopters	365	365		1884	1884		3768
CH-47	na	Helicopters	365	365		226	226		452
BO-105 (BO105)	na	Helicopters	365	365		3316	3316		6632
Sikorsky S-65 (S65)	na	Helicopters	365	365		1131	1131		2262
C-130J	242	Transient Military	365	365	0.5	242	242	242	726
P-8	34	Transient Military	365	365	1.0	34	34	68	136
EA-18G	11	Transient Military	365	365	1	11	11	22	44
Total								**GRAND TOTAL:**	**84875**

Table 4-2. Billings International Airport Proposed Action Annual Operations

Group	Sorties at Full Unit Strength	Unit / Description	# of Flying Days	Basis of Sorties (# of days)	Patterns per Sortie	Annual Departures	Annual Arrivals	Annual Closed Pattern Operations	Total Annual Operations
MTARNG									
CH-47	122	MTARNG	365	365	4.8	122	122	1171	1415
UH-60	122	MTARNG	365	365	4.8	122	122	1171	1415
LUH-72	122	MTARNG	365	365	2.7	122	122	659	903
								TOTAL:	**1415**
Civil and Transient Aircraft									
Bombardier Q400 (modeled as DHC-830)	na	Civil Aircraft	365	365		2001	2001		4002
Airbus A-319/A-320 (A320)	na	Civil Aircraft	365	365		2823	2823		5646
Embraer ERJ-175 (BAE-146)	na	Civil Aircraft	365	365		3502	3502		7004
Cessna 402 (Beechcraft Baron 58P)	na	Civil Aircraft	365	365		6503	6503		13006
Boeing 737-800 (B737-700)	na	Civil Aircraft	365	365		500	500		1000
Bombardier CRJ-550 (Bombardier CL-601)	na	Civil Aircraft	365	365		1501	1501		3002
Boeing 757-200 (B757-200-RR)	na	Civil Aircraft	365	365		572	572		1144
Airbus A-300-600 (A300)	na	Civil Aircraft	365	365		1001	1001		2002
Boeing 767 (B767-CF6)	na	Civil Aircraft	365	365		858	858		1716
GA Prop (GA Single Engine Variable Wing)	na	Civil Aircraft	365	365	0.5	10125	10125	10125	30375
Cessna 500	na	Civil Aircraft	365	365		602	602		1204
Beech Super King Air (C-12)	na	Civil Aircraft	365	365		377	377		754
H-60 (S70)	na	Helicopters	365	365		1884	1884		3768
CH-47	na	Helicopters	365	365		226	226		452
BO-105 (BO105)	na	Helicopters	365	365		3316	3316		6632
Sikorsky S-65 (S65)	na	Helicopters	365	365		1131	1131		2262
C-130J	242	Transient Military	365	365	0.5	242	242	242	726
P-8	34	Transient Military	365	365	1.0	34	34	68	136
EA-18G	11	Transient Military	365	365	1	11	11	22	44
Total								**TOTAL:**	**84875**
								GRAND TOTAL:	**86290**

4.2 Runway Utilization

Although the MTARNG and BFS helicopters will only arrive and depart from the pad at BFS, the DNL noise contours surrounding the airfield are primarily a product of the civil and transient military aircraft runway utilization at KBIL. The modeled runway utilization for civil and transient fixed wing aircraft at KBIL is displayed in Table 4-3. During the data collection process, ATC provided radar data figures which displayed annual operations on each runway for both air carrier/air taxi aircraft and GA aircraft. The annual operations were converted to average annual utilization percentages and were validated by ATC for use in the noise model.

Table 4-3. Modeled Civil and Transient Aircraft Runway Utilization at KBIL

Baseline Civil Aircraft		10L	28R	10R	28L	07	25
Civil Air Carrier/Air Taxi	Arrival	37%	62%				1%
	Departure	29%	70%				1%
Civil GA Aircraft	Arrival	24%	52%	6%	11%	2%	5%
	Departure	20%	59%	3%	13%	3%	2%
	Closed Pattern	21%	59%	6%	14%		
Transient Fixed Wing Aircraft		**10L**	**28R**	**10R**	**28L**	**07**	**25**
All Transient Aircraft	Arrival	37%	62%				1%
	Departure	29%	70%				1%
	Closed Pattern	30%	70%				

4.3 Percentages of Operations During Acoustic Day and Acoustic Night

It is important to account for airfield operations that occur during "acoustic" night (between 10:00 p.m. and 7:00 a.m.) because the DNL metric applies an additional 10 dB to nighttime events, to account for the added intrusiveness of sounds that occur during normal sleeping hours. BRRC requested the annual number of arrival and departure operations that occur during this acoustic nighttime period. The data that was provided by KBIL has the total annual operations of both air carrier / air taxi and GA aircraft groups during 1-hour blocks for 24 hours. The annual operations between 10:00 p.m. and 7:00 a.m. were summed, and the annual totals were converted to percentages during the acoustic daytime and acoustic nighttime periods. Table 4-4 displays the acoustic day and acoustic night percentages applied to the annual operations for each aircraft category modeled in the noise analysis. For the Proposed Action MTARNG operations, the estimate of percentages of operations during acoustic day and acoustic night was based on current operations at the Helena ARNG aviation location during those acoustic daytime and nighttime hours.

Table 4-4. Modeled Percentages of Operations during Acoustic Day and Acoustic Night at KBIL

Operation	Civil Air Carrier/Air Taxi		Civil GA Aircraft		Transient Military Aircraft		Proposed Action MTARNG	
	Acoustic Day	Acoustic Night	Acoustic Day	Acoustic Night	Acoustic Day	Acoustic Night	Acoustic Day	Acoustic Night
	0700 to 2200	2200 to 0700	0700 to 2200	2200 to 0700	0700 to 2200	2200 to 0700	0700 to 2200	2200 to 0700
Arrivals	84%	16%	90%	10%	95%	5%	97%	3%
Departures	90%	10%	96%	4%	95%	5%	97%	3%
Patterns			100%	0%	100%	0%	100%	0%

4.4 Modeled KBIL Weather Data, Runway Coordinates, and Annual Tower Counts

Annual weather data is required for the noise model because noise propagation is dependent on the temperature, atmospheric pressure, and relative humidity. The noise model computes a noise propagation value of each month's weather data and selects the temperature, atmospheric pressure, and relative humidity of the month with the average noise propagation among the 12 months. Table 4-5 displays the 5-year average of each month's weather data at KBIL between years 2016 and 2020.

Table 4-5. KBIL 5-year Monthly Average Weather Data (2016-2020)

Month	Temp (deg F)	Pressure (in-Hg)	Humidity (%)
January	26.7	26.2	63.4
February	24.6	26.3	59.4
March	36.2	26.3	56.9
April	45.8	26.3	53.5
May	56.0	26.3	54.2
June	66.5	26.2	46.8
July	74.2	26.3	38.7
August	71.7	26.3	37.3
September	60.3	26.3	46.1
October	45.2	26.3	52.4
November	37.8	26.3	55.7
December	28.2	26.3	55.9

Source: Weather Underground

Additional data collected for the noise analysis includes the KBIL runway and BFS helipad coordinates used in the noise model. This data is displayed in Table 4-6. ATC provided Air Traffic Activity Report (ATAR) annual tower counts for 2016 through 2020. This data is displayed in Table 4-7 and is used to determine the total number of air carrier / air taxi, GA and transient military aircraft to model for the noise analysis. The 5-year average is used as the baseline for the number of annual operations for No Action. Note that the 5-year average is 2 annual operations greater than the baseline number of modeled annual operations due to rounding of arrival, departure, and closed pattern operations to the nearest whole number of an operation.

Table 4-6. KBIL Runway and Billings Flying Service Helipad Modeling Information

Billings International Airport	Threshold Lon		Threshold Lat		Width ft	Elevation ft
10L	108-33.289	W	45-48.7635	N	150	3584.4
28R	108-30.990667	W	45-48.123167	N	150	3488.2
07	108-33.503833	W	45-48.4605	N	75	3636.3
25	108-32.217	W	45-48.555322	N	75	3533.8
10R	108-33.977857	W	45-48.60928	N	75	3662.3
28L	108-33.14712	W	45-48.378475	N	75	3614.0
Billings Flying Service Helipad	108-34.233	W	45-48.546	N	50	3681.0

Table 4-7. KBIL Annual Tower Operations from the Air Traffic Activity Reports

Year	Itenerant Air Carrier	Itenerant Air Taxi	Itenerant GA	Itenerant Military	Local Civil	Local Military	Total
2016	10,295	25,810	23,956	0	17,778	901	**78,740**
2017	10,908	26,540	26,997	0	17,218	470	**82,133**
2018	11,682	26,314	25,946	0	22,963	967	**87,872**
2019	12,248	28,965	24,662	0	23,282	968	**90,125**
2020	11,435	28,400	24,440	0	20,012	1,227	**85,514**
Average	11,314	27,206	25,200	0	20,251	907	**84,877**
Maximum	12,248	28,965	26,997	0	23,282	1,227	**92,719**

5 DNL NOISE RESULTS

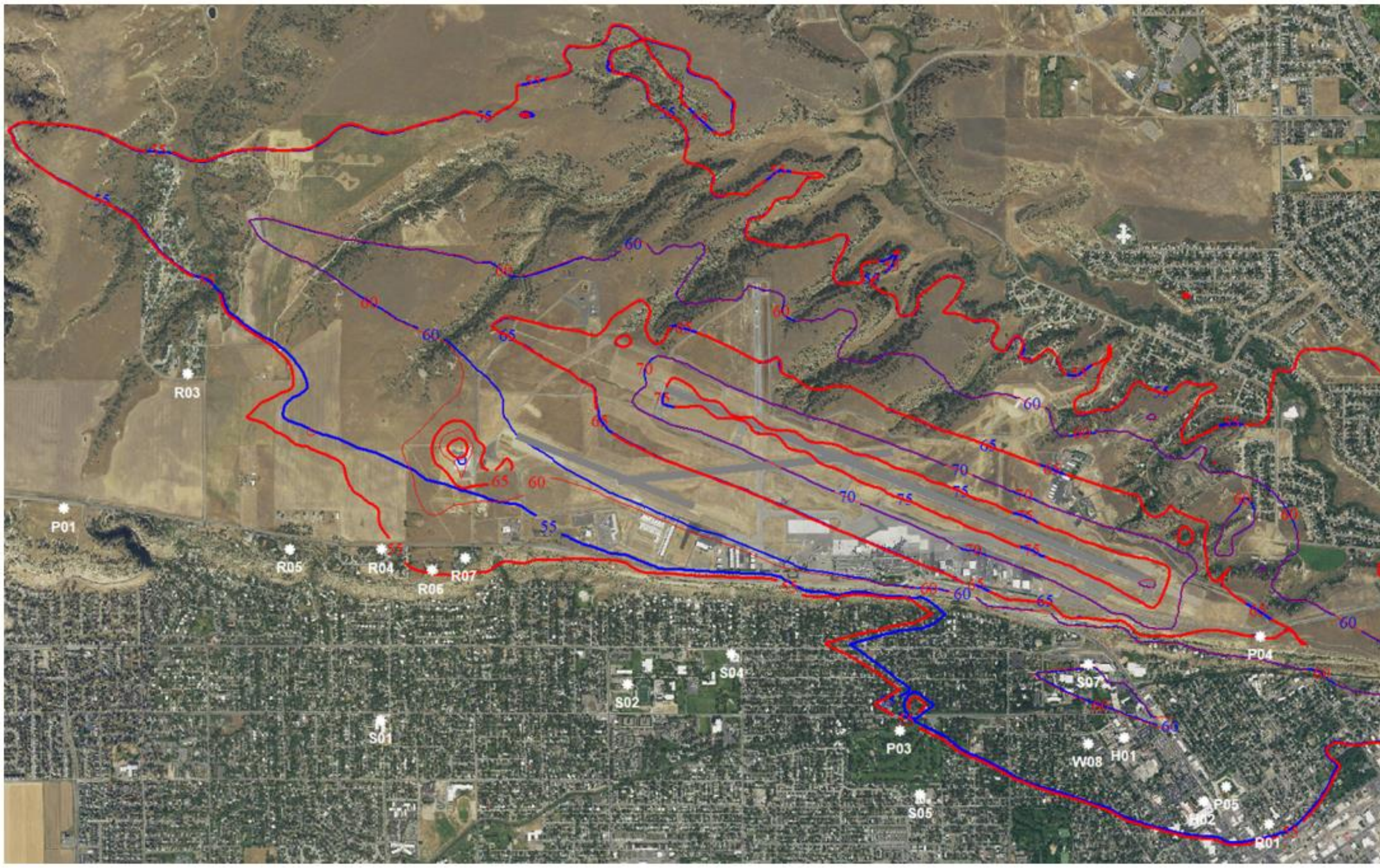


Figure 5-1 presents the No Action DNL noise contours in blue vs the Proposed Action DNL noise contours in red. DNL contour levels of 55 through 80 dBA are displayed in this map. The DNL contour map shows that the Proposed Action DNL contours fall directly over the baseline No Action DNL contours for most areas surrounding the airfield. However, directly south of the proposed LAASF, the Proposed Action 55 dBA DNL contour extends south of N 27th Street to the Rimrock boundary. The Proposed Action 60 and 65 dBA DNL contours south of the proposed LAASF do not extend south of N 27th Street and remain within 1,500 ft of the BFS helipad. For the lobe of the 55 dBA DNL contour that extends into Billings south of N 27th Street, the eastern Proposed Action helicopter operations push the contour outside of the 55 dBA No Action DNL contour by 50 to 200 ft, depending on location along the DNL lobe. Figure 5-2 shows a zoomed-in image closer to the BFS helipad of the No Action (in blue) and Proposed Action (in red) DNL contours.

Table 5-1 presents the DNL levels at the Points of Interest (POI) for the Proposed Action, the No Action, and the difference between the Proposed Action and No Action. The only location that has a 65 dBA or greater DNL in the Proposed Action is Swords Park (P04) at 65.9 dBA. However, the No Action DNL at Swords Park is the same value as the Proposed Action (the difference is 0); there is no increase in DNL at Swords Park under the Proposed Action. Residential locations R04, R06, and R07 (Masterson Circle, Stoney Ridge Circle, and Sky Ranch communities) have an increase of 3.7, 4.2, and 5.2 dBA, respectively, for the Proposed Action over the No Action. However, all residential locations have a DNL of less than 60 dBA for the Proposed Action. Only one other residential location (R05 – Wyatt Circle Community) has a DNL increase of greater than 1 dBA for the Proposed Action. Two schools, S01 – Poly Drive Elementary and S04 – Rimrock Learning Center, have a DNL increase of greater than 1 dBA, but the DNL levels are less than 55 dBA at these schools under the Proposed Action.

Table 5-2 presents the probability of awakening (PA) at the POI for the Proposed Action, the No Action, and the difference between the Proposed Action and No Action for the windows open and windows closed Noise Level Reduction (NLR) conditions. The greatest Proposed Action increase for the windows open is 0.2% at three residential POI locations. The greatest Proposed Action increase for the windows closed is 0.1% at 22 POI locations.

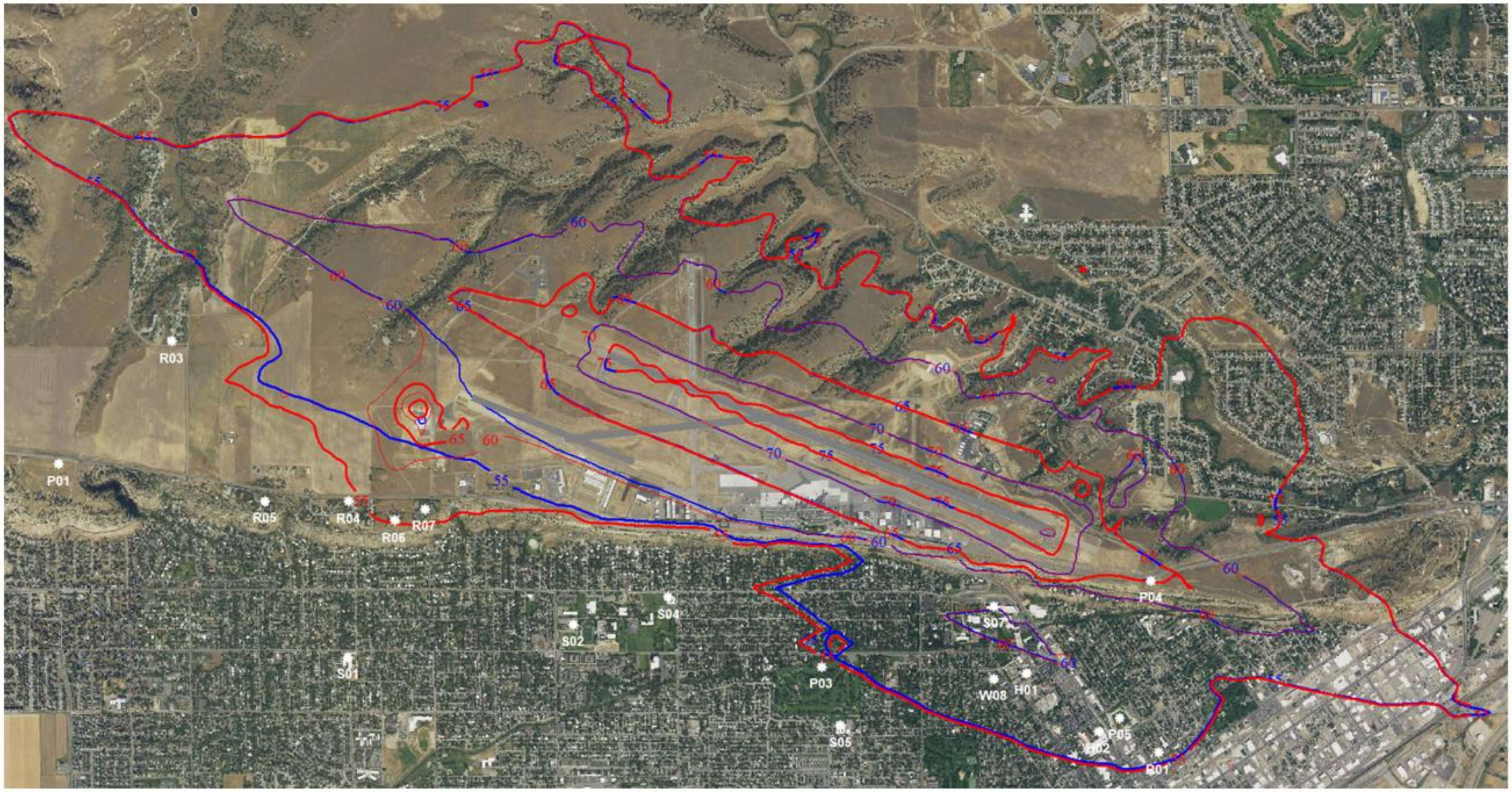


Figure 5-1. MTARNG Noise Analysis Proposed Action 55-80 dBA DNL Contours in Red and No Action DNL Contours in Blue

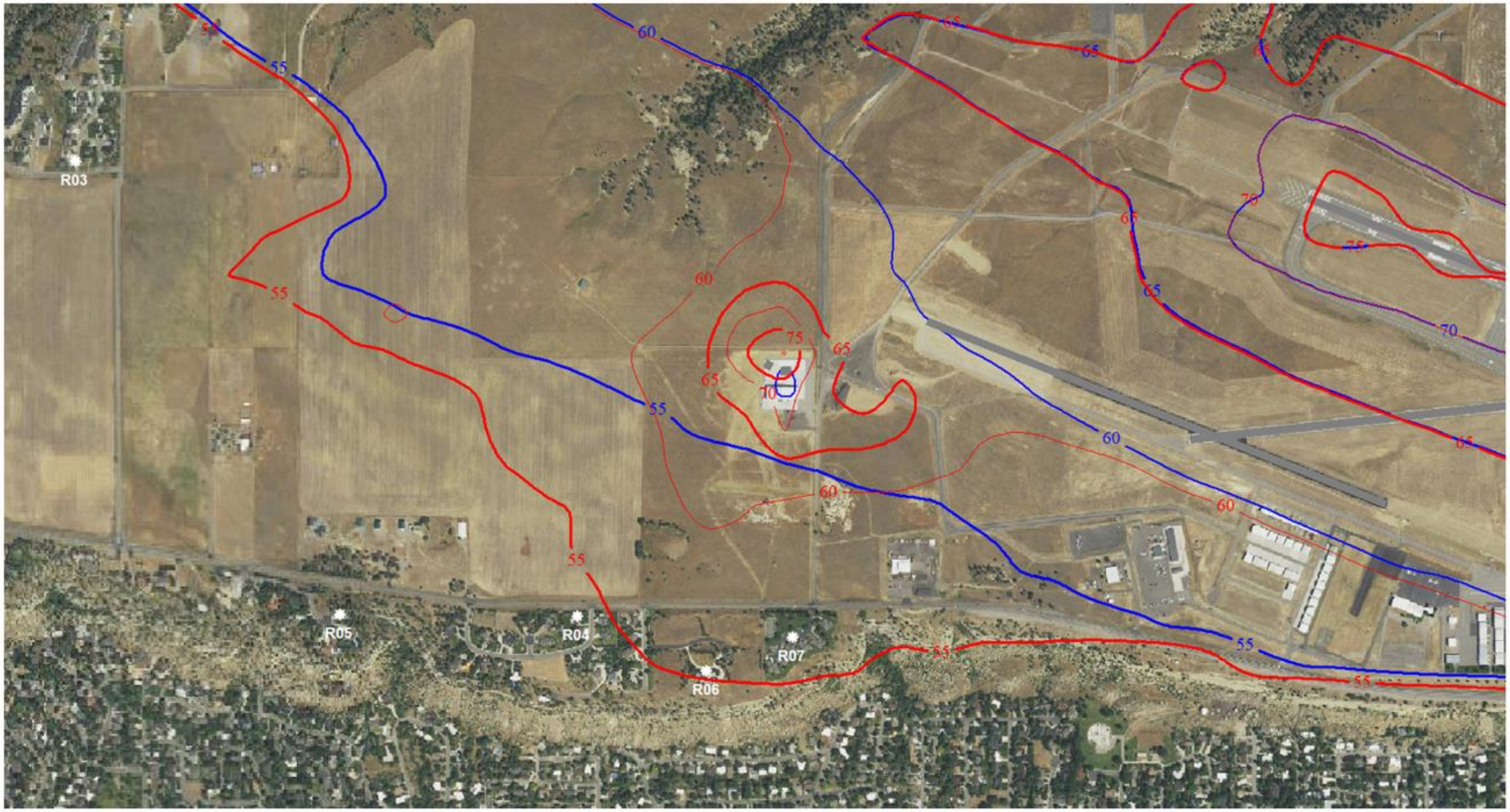


Figure 5-2. Zoomed-in Image of the MTARNG Noise Analysis Proposed Action 55-80 dBA DNL Contours in Red and No Action DNL Contours in Blue

Table 5-1. DNL Results for the Proposed Action and No Action at the Points of Interest

Point of Interest			DNL Results		
Type	ID	Description	No Action DNL (dBA)	Proposed Action DNL (dBA)	Delta (Proposed minus No Action) (dBA)
Hospitals	H01	St. Vincent Healthcare	58.5	58.6	0.1
	H02	Billings Clinic Hospital	56.7	56.8	0.1
Library	L01	Billings Public Library	53.3	53.4	0.1
Prison	O01	Montana Women's Prison	49.2	49.3	0.1
Parks	P01	Zimmerman Park	50.8	51	0.2
	P02	Poly Vista Park	48	48.1	0.1
	P03	Hilands Golf Club	54.2	54.4	0.2
	P04	Swords Park	65.9	65.9	0
	P05	Dehler Park	57.4	57.5	0.1
Residential	R01	Prairie Tower Apartments	55.5	55.6	0.1
	R02	Sage Tower Retirement Apartments	52.5	52.6	0.1
	R03	Rifle Creek Trail Community	53.2	53.4	0.2
	R04	Masterson Circle Community	50.4	54.1	3.7
	R05	Wyatt Circle Community	49.3	51.1	1.8
	R06	Stoney Ridge Circle Community	51.5	55.7	4.2
	R07	Sky Ranch Community	51.4	56.6	5.2
Schools	S01	Poly Drive Elementary School	44.9	46.1	1.2
	S02	Rocky Mountain College	49.5	50.5	1
	S03	McKinley Elementary School	53.3	53.4	0.1
	S04	Rimrock Learning Center	51.6	53.3	1.7
	S05	Highland Elementary School	52.3	52.5	0.2
	S06	Billings Senior High School	50.5	50.6	0.1
	S07	Montana State University Billings	58.1	58.3	0.2
	S08	Billings Central Catholic High School	48.5	48.6	0.1
	S09	Orchard Elementary School	44.3	44.3	0
	S10	Riverside Middle School	44.2	44.3	0.1
	S11	Arrowhead Elementary School	48.3	48.4	0.1
Places of Worship	W01	Trinity Lutheran Church	49.7	49.8	0.1
	W02	First Baptist Church	49.5	49.7	0.2
	W03	St. Nicholas Orthodox Church	48.5	48.6	0.1
	W04	First Christian Church	53.2	53.3	0.1
	W05	American Lutheran Church	50.3	50.4	0.1
	W06	First Congregational United Church	52.7	52.8	0.1
	W07	St Patrick Co Cathedral	51.1	51.3	0.2
	W08	First English Lutheran Church	58.2	58.3	0.1

Table 5-2. Probability of Awakening for the Proposed Action and No Action at the Points of Interest

Point of Interest			Nighttime Sleep Disturbance					
			Windows Open			Windows Closed		
Type	ID	Description	No Action Probability of Awakening (%)	Proposed Action Probability of Awakening (%)	Delta (Proposed minus No Action) (%)	No Action Probability of Awakening (%)	Proposed Action Probability of Awakening (%)	Delta (Proposed minus No Action) (%)
Hospitals	H01	St. Vincent Healthcare	15.5	15.6	0.1	6.3	6.4	0.1
	H02	Billings Clinic Hospital	14.4	14.5	0.1	5.1	5.2	0.1
Library	L01	Billings Public Library	10.9	11	0.1	4	4.1	0.1
Prison	O01	Montana Women's Prison	6.9	7	0.1	1.3	1.3	0
Parks	P01	Zimmerman Park	5.5	5.6	0.1	1.8	1.8	0
	P02	Poly Vista Park	3.3	3.3	0	1.3	1.3	0
	P03	Hilands Golf Club	10.7	10.8	0.1	4.2	4.3	0.1
	P04	Swords Park	21.5	21.6	0.1	13.1	13.2	0.1
	P05	Dehler Park	15	15.1	0.1	6	6.1	0.1
Residential	R01	Prairie Tower Apartments	14	14.1	0.1	5.2	5.3	0.1
	R02	Sage Tower Retirement Apartments	10.7	10.8	0.1	2.6	2.7	0.1
	R03	Rifle Creek Trail Community	8.8	8.9	0.1	3.2	3.3	0.1
	R04	Masterson Circle Community	8	8.2	0.2	1.9	2	0.1
	R05	Wyatt Circle Community	6.7	6.8	0.1	1.3	1.4	0.1
	R06	Stoney Ridge Circle Community	9	9.2	0.2	2.3	2.4	0.1
	R07	Sky Ranch Community	9	9.2	0.2	2.2	2.3	0.1
Schools	S01	Poly Drive Elementary School	4	4.1	0.1	0.4	0.4	0
	S02	Rocky Mountain College	6.5	6.6	0.1	1.3	1.4	0.1
	S03	McKinley Elementary School	10	10.1	0.1	3.5	3.6	0.1
	S04	Rimrock Learning Center	7.4	7.5	0.1	3.3	3.4	0.1
	S05	Highland Elementary School	8.9	9	0.1	3.1	3.2	0.1
	S06	Billings Senior High School	7.9	8	0.1	2.2	2.2	0
	S07	Montana State University Billings	15.5	15.6	0.1	6.5	6.6	0.1
	S08	Billings Central Catholic High School	6.8	6.9	0.1	0.8	0.8	0
	S09	Orchard Elementary School	4.6	4.7	0.1	0.4	0.4	0
	S10	Riverside Middle School	4.6	4.7	0.1	0.5	0.5	0
	S11	Arrowhead Elementary School	3.6	3.6	0	1.3	1.3	0
Places of Worship	W01	Trinity Lutheran Church	7.3	7.4	0.1	1.2	1.2	0
	W02	First Baptist Church	7.4	7.5	0.1	1.3	1.4	0.1
	W03	St. Nicholas Orthodox Church	6.7	6.8	0.1	0.7	0.7	0
	W04	First Christian Church	10.8	10.9	0.1	3.5	3.6	0.1
	W05	American Lutheran Church	8.1	8.2	0.1	2.2	2.3	0.1
	W06	First Congregational United Church	10.6	10.7	0.1	3.6	3.7	0.1
	W07	St Patrick Co Cathedral	9.1	9.2	0.1	2.6	2.7	0.1
	W08	First English Lutheran Church	13.4	13.5	0.1	5.7	5.8	0.1

6 SUMMARY OF THE NOISE ANALYSIS

For both the No Action and Proposed Action noise analysis, the DNL 65 dBA contours stays on BFS and KBIL airport property except for a small piece that extends east of Airport Rd into Swords Park. The major contributors of the DNL contours surrounding KBIL are the large and heavy air carrier jets such as the Boeing 737 and Airbus A320. The Proposed Action 55 dBA DNL contour is either directly on top of the No Action 55 dBA DNL contour or is within 100 ft of the contour for much of the perimeter of the contour. The Proposed Action DNL contours only extend outside of the No Action contour in the areas south and southwest of the proposed MTARNG LAASF. The primary contributors to the Proposed Action contour in these areas are the Coulson procedure East arrivals and departures and the Runway 10R closed patterns of the MTARNG helicopters.

For the POI noise analysis, only 1 location, the Swords Park (P04), has a DNL over 65 dBA. However, there is no increase in the Proposed Action at this park location. The largest impacts for the Proposed Action are at the locations directly south of the proposed LAASF. These include R04 – the Masterson Circle Community (increase of 3.7 dBA), R06 – the Stoney Ridge Circle Community (increase of 4.2 dBA), R07 – the Sky Range Community (increase of 5.2 dBA), S04 – the Rimrock Learning Center (increase of 1.7 dBA), and S01 – Poly Drive Elementary School (increase of 1.2 dBA). It is important to note that the DNL at each of these locations is less than 60 dBA in the Proposed Action. For acoustic nighttime operations, the Proposed Action results in at most a 0.2% increase in the probability of awakening at the POI locations.

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APPENDIX A MODELED AIRCRAFT FLIGHT TRACKS

Appendix A shows the individual flight tracks for all modeled MTARNG helicopters, Billings Flying Service helicopters, civil aircraft, helicopters, and transient military aircraft at KBIL.

APPENDIX B REPRESENTATIVE FLIGHT PROFILES

Appendix B shows one representative flight profile of each operation type for all aircraft modeled in the noise study.